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NATIONAL DAM INSPECTION PROGRAM. CRYSTAL DAM, NDS ID NUMBER PA---ETC(U)
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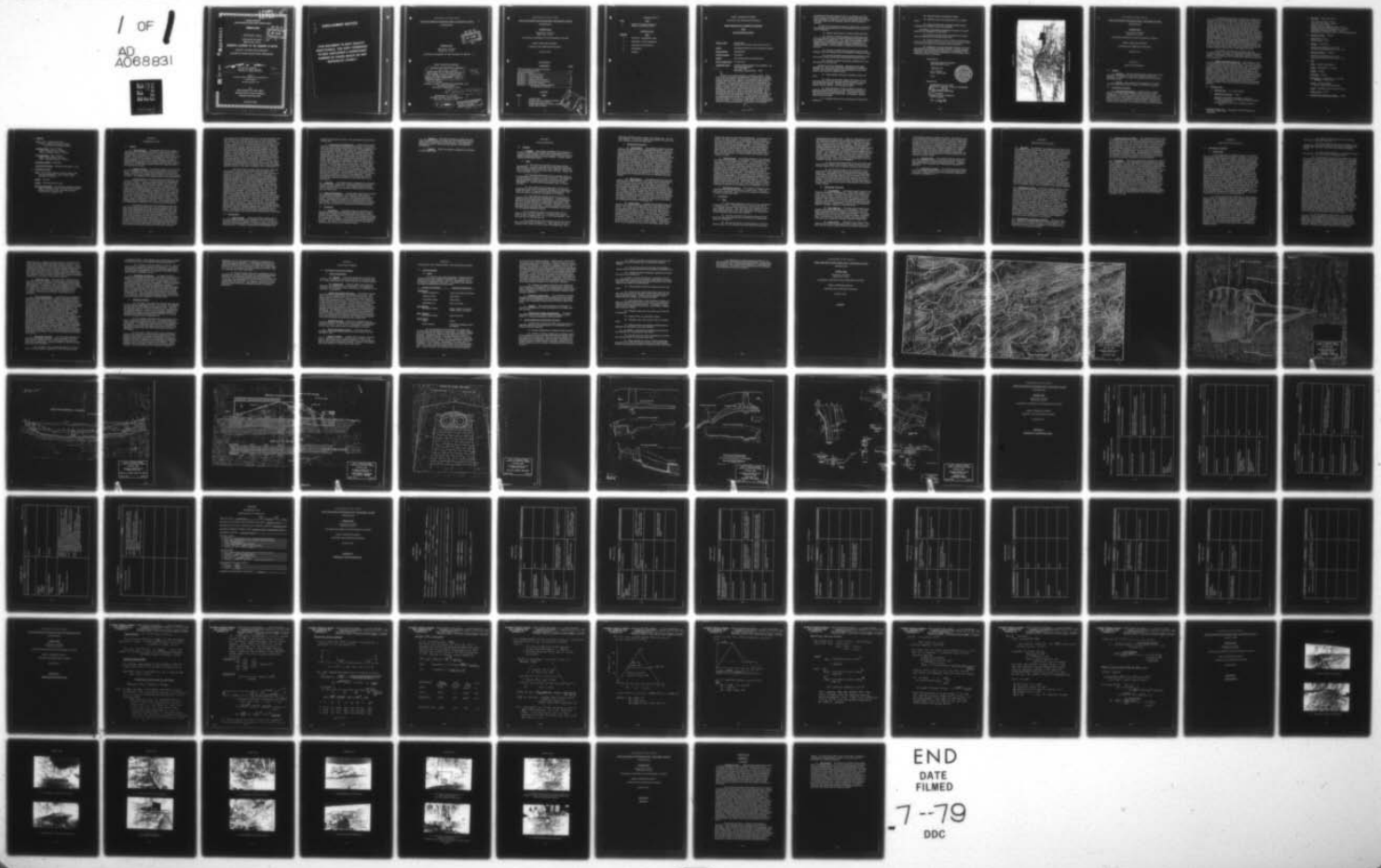

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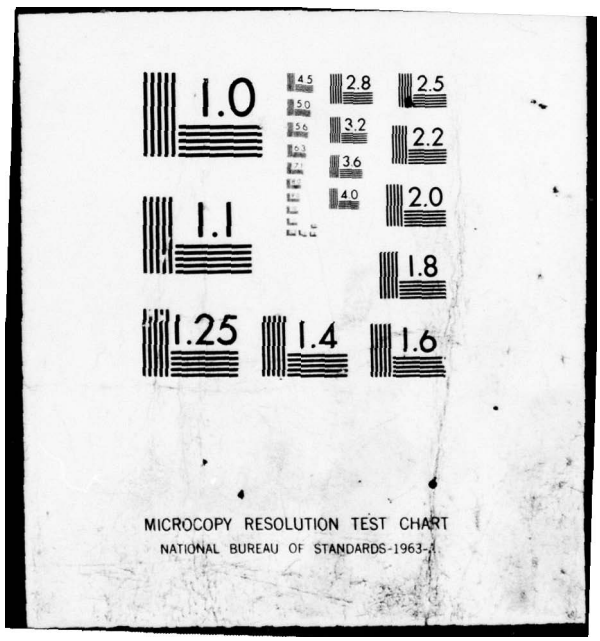
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DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID NO. PA-00677
DER ID NO. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

AUGUST 1978

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DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT

(6) NATIONAL DAM INSPECTION PROGRAM

Crystal Dam, NDS ID Number PA-00677, DER ID Number 54-15. Municipal Authority of the Township of Blythe. Delaware River Basin, West West Branch Schuylkill River, Schuylkill County, Pennsylvania. Phase I Inspection Report.

(12) 91 p.

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For (15) DACW31-78-C-0046

DEPARTMENT OF THE ARMY
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DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Crystal Dam (NDS ID No. PA-00677; DER ID No. 54-15)
Owner:	Municipal Authority of the Township of Blythe
State Located:	Pennsylvania
County Located:	Schuylkill
Stream:	West West Branch Schuylkill River
Date of Inspection:	29 June 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

Based on the visual inspection, available records, calculations and past operational performance, Crystal Dam is judged to be in good condition. However, the spillway will not pass the Probable Maximum Flood (PMF) or one-half of the PMF without overtopping. If Crystal Dam should fail due to overtopping, the hazard to loss of life downstream from the dam would be significantly increased from that which would exist just prior to overtopping. Based on criteria established for these studies by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway capacity is rated as seriously inadequate. The existing spillway can accommodate a flood with a peak inflow of 37 percent of the PMF peak flow. If the low areas of the top of the embankment were brought up to design grade, the spillway could accommodate a flood with a peak inflow of 61 percent of the PMF peak inflow. The spillway would then be rated as inadequate instead of seriously inadequate. Furthermore, the analyses

performed for this study indicate that if, in addition to raising the low areas to design grade, a more detailed watershed study were undertaken, it might be found that the spillway can pass the PMF peak inflow and the spillway capacity might be rated as adequate.

In view of the concern for safety of Crystal Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Restore embankment to original design elevation.

(2) Perform a detailed mapping and hydrologic study of the watershed to more accurately ascertain the required spillway capacity of Crystal Dam. The study should include a determination of all contributing drainage areas, determination of critical features for inflow control, hydraulic capacities of all outflow facilities, and the effects of regulation at the diversion structure.

(3) Replace or modify the pipe bridge across the left spillway so that no supports are in the spillway discharge channel.

(4) Fill the excavated area between the diversion channel and the channel of the West West Branch Schuylkill River.

(5) Develop a detailed emergency operation and warning system for Crystal Dam.

In order to correct operational, maintenance and repair deficiencies, and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Clear spillway discharge channels of brush and trees.

(2) Clean out the small channel that drains the wet area along the toe of the dam near the left abutment so the wet area is properly drained. Install a weir to measure outflow, monitor the area visually, and maintain records.

(3) Make provisions, such as drains or ditches, to drain the wet area along the toe 50 feet right of the gatehouse. Measure outflow and maintain records. If conditions worsen they should be thoroughly studied and, if necessary, remedial action should be taken.

(4) Visually monitor wet area along toe 30 feet left of gatehouse.

(5) Remove brush on embankment slopes.

(6) Maintain valves and operate them on a regular basis.

(7) Make provisions for operating blowoff without damaging the waterline in the outlet channel.

In addition, the following operational measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Crystal Dam during periods of unusually heavy rains.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

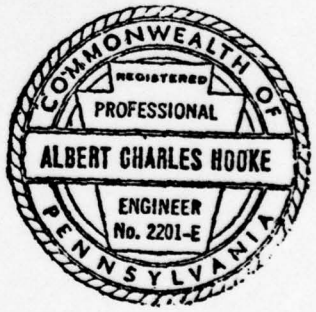
(3) Implement an annual inspection program of all project features and maintain inspection records. Special attention should be given to monitoring alterations of any features of the watershed. The effects of any alterations on the hydrology of the watershed should be evaluated.

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

A. C. HOOKE
Head, Dam Section

Date:



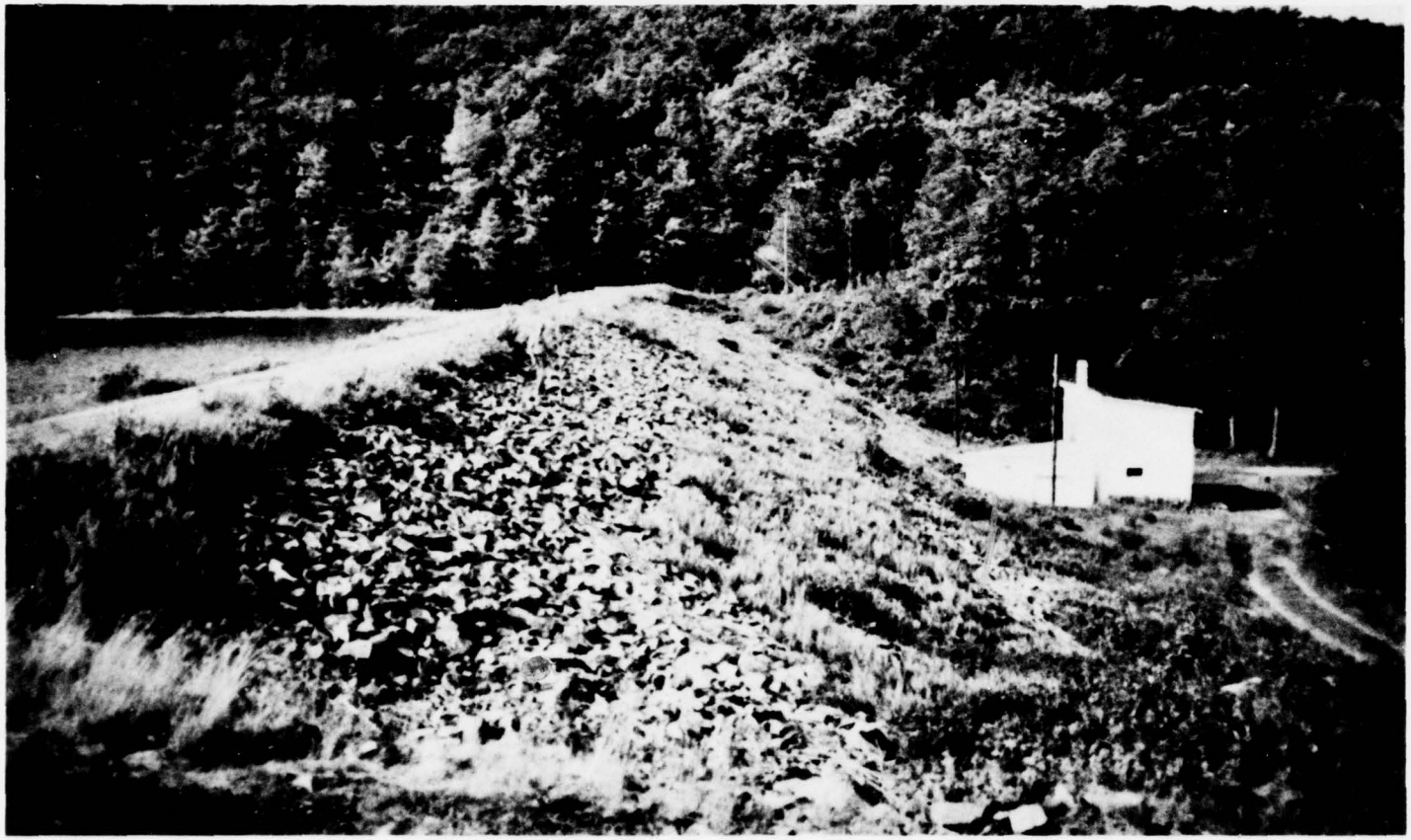
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date: 11 Sep 78

CRYSTAL DAM



View from Right Abutment

DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Crystal Dam is a zoned embankment consisting of a large earthfill zone and a small rockfill zone. The rockfill zone is on the downstream side. The embankment is 450 feet long and 38 feet high, and it has a top width of 12 feet. The upstream slope is riprapped and the downstream slope is the surface of the rockfill zone. A spillway is located at each abutment, and discharge channels convey spillway

As originally constructed, the dam had a straight overflow spillway at each abutment that consisted of an excavated channel. In 1927, a low weir about 1 foot high was constructed across each channel. In 1935, a diversion structure was constructed upstream from the dam and a 3,500-foot long diversion channel was excavated around the right side of the reservoir. The purpose of the diversion works was to convey acid water from Crystal Run, which was then known as Buck Run, and turbid floodwater from the West West Branch Schuylkill River around the reservoir. The diversion channel emptied into the right spillway discharge channel. The right spillway crest, which was originally aligned parallel with the axis of the dam, was re-constructed so that its centerline extended upstream perpendicular to the axis of the dam. As a result, the right spillway functions as a side-channel spillway that discharges into the diversion channel. As part of the work, the new right spillway was constructed so that it had a main spillway section with a crest length of 36 feet and a raised auxiliary section with a crest length of 54 feet.

The original drainage area for Crystal Dam was 5.1 square miles. However, the watershed has been extensively altered by strip mines, highway construction, and the diversion channel. The alterations have significantly affected the hydrology of the watershed.

h. Normal Operational Procedure. The reservoir is normally maintained at the left spillway crest level, which is about 0.5 foot lower than the right spillway crest. Water for distribution is withdrawn from a 20-inch line through the dam. The water is treated at facilities located at the toe of the dam and then distributed by a gravity line. Some water is also pumped to surrounding communities. The valve on the 20-inch blowoff line is normally closed. Acid water from Crystal Run bypasses the reservoir by way of the diversion channel. Gates located at the diversion structure are normally closed so that water from the West West Branch Schuylkill River normally enters the reservoir. However, during periods of high turbidity, the gates are opened to allow the water to enter the diversion channel and bypass the reservoir.

1.3 Pertinent Data.

a. Drainage Area. 5.1 square miles.*

b. Discharge at Damsite. (cfs.)

Maximum known flood at damsite - unknown.
Emergency drawdown line at maximum pool elevation - 90 (approximate).
Spillway capacity with pool at Elevation 1228.5 - 2,680.

* Original drainage area. Strip mining and diversions have extensively altered the watershed.

c. Elevation. (Feet above msl.)

Top of dam (design) - 1230.0.
Top of dam (low spot) - 1228.5.
Maximum pool - 1228.5.
Normal pool (left spillway crest) - 1224.1.
Upstream intake invert outlet works - 1193.0.
Downstream invert outlet works - 1192.2.
Streambed at centerline of dam - 1192.0 (approximate).

d. Reservoir Length. (Miles.)

Normal pool - 0.36.
Maximum pool - 0.37.

e. Storage. (Acre-feet.)

Normal pool (spillway crest) - 200.
Maximum pool (design top of dam) - 310.

f. Reservoir Surface. (Acres.)

Normal pool (spillway crest) - 18.
Maximum pool (design top of dam) - 19.

g. Dam.

Type - Earthfill embankment.

Length - Embankment - 450 feet.

Height - 38 feet.

Top Width - 12 feet.

Side Slopes - Downstream - 1V on 1.9H.
Upstream - 1V on 3.5H.

Zoning - Mostly earthfill;
small rockfill zone downstream.

Cutoff - Earthfilled cutoff trench into rock.

Grout Curtain - None.

h. Diversion and Regulating Tunnels. None.

i. Spillway.

Type - Left - rounded-crest weir.
Right - rounded-crest side-channel; has main and auxiliary sections.

Length of Weir - Left - 38 feet.
Right - main section - 36 feet.
Right - auxiliary section - 54 feet.

Crest Elevation - Left - 1224.1.
Right - main section - 1224.6.
Right - auxiliary section - 1225.8.

Upstream Channel - Reservoir.

Downstream Channel - Channels excavated in rock.

j. Regulating Outlets.

Type - Two 20-inch diameter cast-iron pipes (CIP) through embankment. One is water supply and other is blowoff.

Length - 270 feet.

Access - Downstream toe of dam.

Regulating Facilities - Two manually operated nonrising stem 20-inch gate valves for each 20-inch CIP in gatehouse at toe of dam. One valve on each 20-inch CIP at upstream end.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Engineering data for the original structures that was available for review was limited to construction drawings of the project features. In 1914, a report on Crystal Dam was prepared by the Pennsylvania Water Supply Commission. That report includes a description of project features and an estimate of the capacity of the spillways. In 1935, a permit application report on the proposed diversion channel indicated that the capacity of the channel would be about 1,000 cfs and that the modified right spillway would not reduce the spillway capacity of the dam.

b. Design Features. The primary features of Crystal Dam are an embankment, a spillway at each abutment, and an outlet works. A general plan of the original features of the project is shown on Plate 2 and a profile along the axis of the dam is shown on Plate 3. Photographs of the existing features are in Appendix D.

The embankment is 450 feet long and 38 feet high, and it has a top width of 12 feet. A section through the embankment is shown on Plate 4. The embankment consists of a large earthfill zone that extends from the upstream slope, which is 1V on 3.5H, to a downstream line of 1V on 1.5H. A rockfill zone adjacent to the downstream side of the earthfill zone completes the embankment to a final downstream slope of 1V on 1.9H. The upstream slope of the embankment is covered with hand-placed riprap to the top of the dam. A cutoff trench with a bottom width of 10 feet was excavated about 20 feet into the rock along the axis of the dam. The bottom of the trench is shown on Plate 3. This trench, called a puddle ditch, was filled with a wet clay that was compacted into the fractures of the rock. The earthfill portion of the embankment is reported to be a mixture of clay and gravel.

As originally constructed, the spillways at each abutment were channels excavated into rock and separated from the ends of the embankment by masonry walls founded on rock. Details of the original spillways are shown on Plate 6. The cutoff trench along the axis of the dam was extended across the spillways to the hillsides, and after being backfilled with earth, a layer of hand-placed stone was laid on the fill to prevent erosion of the material during spillway discharges. In 1927, low, rounded-crest concrete weirs were constructed across each spillway. In 1935, a diversion structure was constructed upstream from the reservoir on the West West Branch Schuylkill River, and a diversion channel was excavated around the right side of the dam.

The purpose of the diversion works was to prevent unsuitable water from Crystal Run, then called Buck Run, and turbid floodwater from the West West Branch Schuylkill River from entering the reservoir. Details of the diversion works are shown on Plate 7 and on Photographs L and M. The downstream end of the diversion channel was at the right spillway discharge channel. The weir across the right spillway was removed and replaced with a new weir whose crest extended upstream perpendicular to the axis of the dam. The new right spillway crest was rounded, and it consisted of a main spillway section 36 feet long and an auxiliary spillway section 54 feet long. The existing spillway of Crystal Dam is the result of these modifications. The left spillway crest is aligned parallel to the axis of the dam (Photograph C). The crest is 38 feet long and is at Elevation 1224.1. The right spillway crest is perpendicular to the axis of the dam and has a main spillway section 36 feet long at Elevation 1224.6 and an auxiliary spillway section 54 feet long at Elevation 1225.8 (Photograph D).

The outlet works is located near the center of the dam and consists of two 20-inch diameter cast-iron pipes (CIP) through the embankment (Plate 4). A masonry intake structure is located in the reservoir at the upstream ends of the pipes. A gatehouse is located at the downstream toe of the embankment. Treatment facilities and a pump are located in another building at the downstream toe. The pipes are supported for their entire length on a stone masonry wall, and the pipes are encased in concrete (Plate 5). The masonry wall is founded on a concrete footing that was placed on the foundation rock. Three masonry seepage cutoffs were constructed along the wall (Plate 4). One is located at the embankment cutoff trench, and two others are located farther upstream. One gate valve is located at the upstream end of each pipe, and two gate valves for each pipe are located in the gatehouse at the downstream toe of the embankment. As originally constructed, there was a wooden truss bridge that led from the top of the dam to the valve stems for the valves at the intake structure (Plate 4). However, that bridge no longer exists, and there is no access to those valves. One 20-inch CIP is a water supply line. Water is drawn from the reservoir, treated onsite, and then distributed by a 12-inch diameter gravity line and by an 8-inch diameter pressure line. The second 20-inch CIP can be used as a sediment blowoff or to drawdown the reservoir. It discharges into a small outlet channel at the toe of the dam that leads to the natural stream channel farther downstream.

2.2 Construction.

a. Data Available. Construction data available for review was limited to information contained in the 1914 report by the Pennsylvania Water Supply Commission. That report was prepared from information obtained by visual inspection and from interviews with J. R. Hoffman, Engineer for the Philadelphia and

Reading Coal and Iron Company, who supervised construction of Crystal Dam.

b. Construction Considerations. Available information suggests that the dam was carefully constructed. The 1914 report by the Pennsylvania Water Supply Commission indicates that the cutoff trench extends 20 feet into rock. It was filled with select material that was wet compacted (puddled) into the fractures in the rock. The materials for the earthfill portion of the embankment were used selectively, with the more impervious materials placed upstream. The earthfill was placed in 6-inch layers, sprinkled, and compacted with a grooved roller. The 20-inch pipes through the embankment were pressure tested to 400 psi, and apparently, there were no leaks. A spring was located at the left abutment and a concrete box was constructed around it. A 4-inch diameter CIP, encased in concrete, leads from the box at the spring to the toe of the dam. A channel carries the water away from the toe of the embankment. During construction, another spring was encountered in the cutoff trench near the right abutment. A french drain was constructed to carry flow from this spring to the toe of the embankment. Overall, the available information indicates that Crystal Dam was unusually well constructed compared to many other dams of the same period.

2.3 Operation. Few formal records of operation are available. The dam has been inspected at irregular intervals by Commonwealth authorities since 1914. The available records indicate that the problems that were observed in this inspection have existed for many years.

2.4 Other Investigations. The available information indicates that additional investigations of Crystal Dam were made by Commonwealth authorities in 1942. Although the information is meager, it appears that the intent of the investigations was to evaluate the hydraulic capacity of the spillways and the diversion channel. There are no reports or correspondence to indicate that any use was made of the results from these investigations.

2.5 Evaluation.

a. Availability. Engineering data was provided by the Division of Dams and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania, and by the Owner, the Municipal Authority of the Township of Blythe. The Owner made available personnel for information and operating demonstrations during the visual inspection. The Owner also researched his files for additional information upon request of the inspection team.

b. Adequacy. The type and amount of design data and other engineering data are limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The general appearance of this project indicated that some project features have deteriorated with age and are in need of repair, while other project features have been properly maintained and are in good condition. Specific observations are described herein.

b. Dam.

(1) The top of the embankment had some vertical irregularities. A survey of the top of the embankment indicated that the level varied from Elevation 1228.5 near the center of the dam to Elevation 1229.5 at the right end of the dam. Design top of dam elevation is 1230.0.

(2) The hand-placed riprap on the upstream slope of the embankment was intact to the top of the dam. The riprap was in good condition except for a growth of ferns and light brush that extended from normal pool level to the top of the dam (Photograph A). Larger brush had apparently been cut earlier this year.

(3) The surface of the rockfill zone that forms the downstream slope of the embankment appeared to be satisfactory except for growth of ferns and light brush (Photograph B). The stone was sound, and placement appeared to be uniform.

(4) A wet area was located along the toe of the embankment at the left abutment (Photograph E). Considerable amounts of clear standing water were present, and the estimated flow from the area was about 5 gallons per minute (gpm). The source of the flow could not be determined. The size of the wet area was about 750 square feet. A small, overgrown channel begins near the wet area and carries flow downstream to the end of the left spillway discharge channel.

(5) A second wet area was located along the toe about 30 feet left of the gatehouse. This area had a slight amount of clear, standing water, but no flow was observed. The wet area was not excessively soft.

(6) A third wet area was located along the toe 50 feet right of the gatehouse (Photograph F). Slight amounts of clear, standing water covered an area of about 450 square feet, and a

damp area covered an area of about 1,250 square feet. No flow was observed. The area was softer than adjacent dry areas, and lush vegetation covered the entire area.

c. Appurtenant Structures.

(1) Left Spillway. The approach channel to the left spillway was clear and had no apparent deficiencies. The concrete weir appeared to be in good condition, and no deficiencies were observed for the stone masonry wall at the left end of the embankment (Photograph C). Immediately downstream from the spillway weir is a support for a pipe bridge that carries an 8-inch diameter pressure line across the left spillway (Photograph C). The discharge channel in this area also had substantial amounts of debris, and considerable brush was growing in the stone lining that covers this portion of the channel. Beyond the stone-lined portion of the discharge channel, the discharge channel is excavated into rock. The right side of the channel is bounded by a dry masonry wall and the left side is bounded by the left hillside. Some trees up to 4 inches in diameter were growing in the fractures in the rock (Photograph G). A small bridge is located across the downstream end of the left spillway discharge channel.

(2) Right Spillway. The approach area for the right spillway had a small amount of light brush growth (Photograph D). The concrete on both the main and auxiliary weir sections was in good condition except for one small area of disintegration about 6 inches in diameter. The right spillway discharges into the diversion channel that was excavated around the right side of the reservoir. Between the spillway weir and the discharge channel, a distance of about 20 feet, there was a considerable growth of brush (Photograph D). Farther downstream, the right spillway discharge channel is similar to the left one in that it is excavated into rock and bounded by a dry masonry wall on one side and by the hillside on the other. A number of small trees were growing in the fractures in the rock (Photograph H).

(3) Outlet Works. A bridge that provided access for operating the valves on the upstream ends of the pipes no longer exists. The valves in the gatehouse at the downstream toe of the dam were badly rusted. The Owner said that they had not been operated in at least 12 years. The 20-inch pipes outlet at a small headwall downstream from the gatehouse. Beyond the headwall is a small outlet channel. At the headwall, the blow-off line terminates and the water supply line is reduced to 12 inches in diameter. The water supply line continues along the outlet channel for about 10 feet, where it enters a small meter house that was constructed in the outlet channel. A gravity line and an 8-inch pressure line come out of the meter house. The

gravity line continues downstream underground. The pressure line crosses the outlet channel, is underground for some distance, and then goes diagonally up the downstream slope of the embankment and crosses the left spillway. During the inspection, the valve on the blowoff was partially opened. It was not opened fully because of a danger of damaging the 8-inch pressure line that crosses the outlet channel. Also, it would have probably stirred up sediment that would be drawn into the water supply line. The gate valve on the blowoff worked easily during the inspection (Photograph P), but slight leakage was observed after closing the valve.

d. Reservoir Area. The slopes adjacent to the reservoir are steep and are covered with hardwoods. No evidence of creep, rock slides, or land slides was visible. The Owner said that sedimentation would be a problem if the diversion works did not convey most of the turbid floodwater around the reservoir. Inspection of the watershed area indicated that it is a very complex watershed with respect to its hydrology. The Owner controls about 20 percent of the area, and the remaining 80 percent is owned by various coal companies. The watershed has been greatly altered by strip mining. The inspection of the watershed indicated that some areas of the original watershed probably do not contribute any inflow to the reservoir (Photograph J). Other areas apparently make only a limited contribution because the runoff enters a flume (Photograph K). Inflow from other areas is bypassed around the dam by the diversion works (Photographs L and M). Additional description of the watershed is in Paragraph 5.1a.(3).

e. Downstream Channel. The channel immediately downstream from the dam passes through a wooded area. After passing through Forestville, which is the first community downstream, it passes through strip mines.

3.2 Evaluation.

a. Dam.

(1) The design elevation for the top of the embankment is Elevation 1230.0. The lowest area on the top of the dam is 1.5 feet lower than the design elevation, and it controls the maximum spillway capacity. Low areas have been reported in previous inspections since 1923, and, apparently, the design grade of the embankment has never been restored.

(2) The ferns and light brush growing among the riprap on the upstream slope and in the rockfill on the downstream slope are undesirable.

(3) The wet area along the downstream toe of the embankment near the left abutment has been described on previous

inspections since at least 1927. However, examination of available information suggests that this flow has existed since the dam was built and that the source of flow to this area is outflow from a spring located at the left abutment. Although the spring outlet could not be found in this inspection, the available information indicates that the spring was boxed in and piped through the embankment to this area. The existence of the small channel with low masonry walls that drains this area supports the conclusion. The condition of that channel, which is overgrown with weeds, shrubs, and small trees, is such that it does not drain the wet area effectively. The lack of adequate drainage causes the large wet area. This could mask the development of any uncontrolled seepage through the embankment.

(4) The wet area along the toe 30 feet left of the gatehouse does not appear to be of great concern at the present time. The area might be the result of surface runoff and poor drainage.

(5) The wet area along the toe 50 feet right of the gatehouse has been reported in previous inspections at least since 1934. Information in the 1914 report by the Pennsylvania Water Supply Commission indicates that the source of the water is a french drain that was constructed to convey water from a spring in the cutoff trench near the right abutment to the toe of the dam. Assuming that this is the case, the only real hazard of the wet area is that it might mask the development of any uncontrolled seepage.

b. Appurtenant Structures.

(1) Left Spillway. The bridge support located in the discharge channel is unsatisfactory. Debris could easily accumulate on the support and substantially reduce the spillway capacity during a flood. Similarly, the debris, brush, and trees in the discharge channel would reduce the capacity of the left spillway. The bridge at the end of the spillway discharge channel has a large opening and is located well downstream from the spillway and dam. Consequently, it would not have significant effects on spillway capacity or tailwater levels.

(2) Right Spillway. The light brush growing in the approach area of the right spillway is undesirable. The small area of disintegration of the concrete on the weir has not yet progressed to the extent that repairs are warranted. The growth of brush between the weir and the diversion channel is undesirable. The trees in the discharge channel could cause debris collection and a reduction in channel capacity during floods.

(3) Outlet Works. Operation of the valves at the upstream ends of the 20-inch pipes would require a diver. However, this is of minor concern because of the type and quality

of construction used in installing the pipes. The pipes are concrete encased and were pressure tested to a head 24 times greater than the maximum head that the pipes would ever experience. Although the valve on the blowoff line opened easily, the rusted condition of the valve is unsatisfactory. Furthermore, the fact that the valve did not re-seal tightly indicates that it probably needs internal maintenance. Although probably not a serious hazard to the dam, the Owner should realize that if it were necessary to open the blowoff under emergency conditions, the force of the outflow might damage the 8-inch pressure line that crosses the outlet channel.

c. Reservoir Area. The altered condition of the watershed has a significant effect on the inflow into the reservoir, and, consequently, on required spillway capacity. A detailed evaluation of the hydrology of the watershed is presented in Section 5.

d. Downstream Channel. No conditions were observed in the downstream channel that might present significant hazard to the dam. Additional discussion of downstream conditions is presented in Paragraph 5.1e.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at the level of the left spillway crest with excess inflow going over the weir and into the downstream channel. One 20-inch diameter cast-iron pipe draws water from the reservoir for water supply. All valves on this pipe are normally open. After the water is treated at the facilities at the toe of the dam, it flows by gravity to distribution networks in the communities of Forestville, Primrose, Llewllyn, Branchdale, Phoenix Park, and Black Heat. Some water is also pumped to the Village of Buck Run. The diversion structure, located upstream from the reservoir, and the diversion channel cause some inflow to be conveyed around the right side of the reservoir. Normally, all flow from Crystal Run, which is undesirable inflow from the standpoint of water quality, enters the diversion channel. In addition, gates on the diversion structure, which is constructed on the West West Branch Schuylkill River, are opened during periods of turbid runoff to keep that water from entering the reservoir. The gates are closed when the flow in the West West Branch Schuylkill River is clear, and the water then enters the reservoir by way of the original stream channel. The valve on the upstream end of the blowoff line is always open, as is the upstream valve at the downstream end. The downstream valve is normally closed, and the blowoff is not normally operated.

4.2 Maintenance of Dam. The dam is visited daily by a caretaker who takes a water sample from the reservoir, checks the reservoir level, and checks the water treatment equipment and the pump. The caretaker is responsible for observing the general condition of the dam and appurtenant structures and for reporting any changes or deficiencies to the Executive Director of the Blythe Township Water Authority. The caretaker, who has been on the job for 12 years, also operates the gates on the diversion structure upstream from the dam as necessary to maintain the quality of the inflow into the reservoir. Gate operation is based on evaluation of watershed conditions and weather forecasts. Penneast Corporation, Engineering Consultant to the Authority, inspects the dam as part of an annual inspection of the water supply system. However, a formal, detailed inspection of the dam for the purpose of monitoring the performance of the embankment and the appurtenant structures is not performed. The brush on the embankment is cut annually.

4.3 Maintenance of Operating Facilities. The water treatment equipment is checked daily and is well maintained. However, except for lubricating the gears and gear tracks on the diversion structure, there is apparently no maintenance of the valves and other operating facilities.

4.4 Warning Systems in Effect. The Owner explained the chain of command procedure that would be followed during an emergency to the inspection team. No formalized notification procedure had been established at the time of the inspection. The Owner related to the inspection team how Crystal Dam, and other dams owned by the Authority, had been kept under constant observation during Tropical Storm Agnes in June, 1972. The vehicle used by the caretaker is equipped with a two-way radio to communicate with the Water Authority office. Responsibility for notification of emergency conditions to local authorities rests on the Executive Director of the water authority, who would base his decision on the engineering consultant's recommendations.

4.5 Evaluation. The normal operational procedure for Crystal Dam is satisfactory, and maintenance of the embankment appears to be adequate. However, the lack of maintenance of the valves and not operating the blowoff on a regular basis are unsatisfactory. The inspection procedures used by the Owner are adequate for evaluating the need for normal repairs and maintenance, but some of the work, such as keeping the spillway channels clear, has not been performed. In addition, the overall condition of the dam and watershed indicates a need for special inspections of the dam and for records of its performance. Surveillance of the dam during storms appears to be adequate, but it relies heavily on the diligence of the personnel involved. Because more than one dam is under their care and because few personnel are involved, the absence of one or more personnel could result in inadequate surveillance of the dam. The emergency warning procedures are too informal, and, in the event of an emergency that would require a quick decision, the surveillance and warning system might not be effective because the consulting engineer who would make the recommendation would not be immediately available at the site.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data.

(1) No hydrologic or hydraulic analyses for the original Crystal Dam design were available for review. In 1914, the Pennsylvania Water Supply Commission estimated the total spillway capacity to be 4,600 cfs. When the diversion works were constructed in 1935, the Commission indicated that the spillway capacity would not be decreased as a result of the modifications. In addition, the capacity of the proposed diversion channel was estimated to be 1,000 cfs. In 1942, additional investigations were made by Commonwealth authorities. They estimated the total combined discharge capacity of the two spillways to be 3,210 cfs under existing conditions, which included low areas on the embankment and limitations on discharge capacity of the right spillway caused by the diversion channel. They also estimated the maximum spillway capacity to be 4,690 cfs , if low areas on the dam were filled and if the capacity of the diversion channel were increased. Based on information from surveys made during this inspection, which differed from data used in the 1942 investigation, the maximum combined spillway capacity for the existing conditions was estimated to be 2,680 cfs, and the maximum capacity of the diversion channel was estimated to be 1,580 cfs (Appendix C). The maximum spillway capacity, based on restoring the embankment to original design level, was estimated in this study to be 4,510 cfs (Appendix C).

(2) In the recommended guidelines for safety inspection of dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended spillway design flood for the size (small) and hazard potential (high) classification of Crystal Dam is from one-half the Probable Maximum Flood (PMF) to the PMF. Because the size of Crystal Dam is close to the upper limit for classification as a small dam and because the downstream area has many houses that would be affected by failure of the dam, the recommended spillway design flood for Crystal Dam is the PMF. If the dam and spillway are not capable of passing the PMF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

(3) The Municipal Authority of the Township of Blythe owns about 20 percent of the Crystal Dam watershed. According to the Owner, the remaining 80 percent is owned by various coal companies. As shown on Plate 1 and Photograph J, the original watershed area has been extensively strip mined in the past. In addition, mining of the area is still active. Inspection of the watershed and interviews with the Owner indicate that past mining has significantly altered the watershed and that future mining will also have effects on inflow into the reservoir. In addition to the direct effects of the mining, which apparently reduce the effective watershed area, there are other controls on the hydrology of the watershed. An irregular earthen flume controls inflow from some portions of the watershed (Photograph K). As shown on Plate 1, the flume goes around the strip mines to deliver water to the reservoir. When the flume capacity is exceeded, the excess water overflows into strip mine pits and, apparently, does not enter the reservoir. In addition to the flume, an interceptor ditch constructed by Commonwealth authorities collects acid runoff from a portion of the watershed. This water flows through a pipe under the flume into the strip mine pits. Inflow to the reservoir is also affected by the diversion structure and diversion channel (Photographs L and M). As shown on Plate 1, water from the Crystal Run subbasin is normally diverted around the right side of the reservoir by way of the diversion channel. When the capacity of the diversion channel is exceeded, the excess water enters the reservoir. The result of the alterations of the watershed and the controls on the inflow is a hydrologic situation that is very complex and beyond the scope of this study. Inadequate mapping makes it impossible to accurately determine how much of the original watershed is effective and irregular cross sections of the flume and diversion channel make it difficult to identify control sections for determining maximum capacities.

(4) For the purposes of this study, two cases were evaluated. Case I evaluated the effects of a storm over what could best be identified by the inspection team as the existing watershed. The analysis utilized information obtained from the Owner concerning ineffective areas, survey information for possible control sections for the flume and diversion channel, and judgment. Because the analysis was based on very limited

information for a complex hydrologic situation, the results are only a preliminary estimate for inflow into the reservoir. A detailed study might yield significantly different results. Case II evaluated the effects of a storm over the original watershed area and ignored ineffective areas, additional drainage areas that might have been captured by the mining, and any controls on inflow into the reservoir. Case II is an analysis for storms before any alteration of the watershed occurred, and, based on available information, is probably a conservative approach.

b. Experience Data. For this study, a PMF peak flow of 7,200 cfs on a 4.8-square mile watershed, previously calculated by the Corps of Engineers, was transposed to the Crystal Dam watershed. For Case I, which is the analysis of the modified watershed, the PMF peak flow was estimated to be 2,210 cfs. For Case II, the analysis of the original watershed area of 5.1 square miles, the PMF peak flow was estimated to be 7,560 cfs. Hydrologic and hydraulic computations are in Appendix C.

c. Visual Observations. On the date of the inspection, conditions were observed in both spillway discharge channels that would reduce the spillway capacity of Crystal Dam during a flood occurrence. A pipe bridge support was constructed near the centerline of the left spillway discharge channel about 35 feet downstream from the weir. Debris could easily become entangled on the structure and reduce the capacity of the spillway. In addition, brush was growing in the discharge channels of both spillways that would reduce the capacities of them. Another problem observed was that the high ground that separates the diversion channel and the channel of the West West Branch Schuylkill River had been excavated at one location where Crystal Run enters the diversion channel (Photograph O). Apparently, the excavation was for the purpose of installing an emergency waterline and was never backfilled. The excavated area would allow flow of water from the diversion channel into the reservoir before its design capacity would be realized. Though significant, none of the aforementioned conditions were included in the hydrologic and hydraulic analyses. The conditions can be eliminated by minor maintenance, and, in view of the great uncertainties concerning the watershed, would not have increased the accuracy of the study.

d. Overtopping Potential. Two cases were analyzed to check the overtopping potential. Case I considered the PMF peak flow for existing watershed conditions to the extent that they could be determined. Case II considered a PMF on the original Crystal Dam watershed.

(1) For Case I, the modified PMF peak is 2,210 cfs, and the existing spillway capacity is 2,680 cfs with the pool

at Elevation 1228.5. This indicates that Crystal Dam is capable of passing the PMF for the existing watershed (Appendix C).

(2) For Case II, the PMF peak is 7,560 cfs. This is greater than the spillway capacity of Crystal Dam. A check of the surcharge storage showed that the surcharge storage effect of Crystal Dam is insufficient to contain the PMF inflow hydrograph without overtopping the dam.

e. Downstream Conditions. As shown on Plate 1, Crystal Dam is located on the West West Branch Schuylkill River. There are no inhabited structures along this river for the first 1.1 miles downstream from the dam. At this location, the river passes through the community of Forestville, which has numerous low-lying structures that would be affected by a failure of Crystal Dam. About 1.6 miles downstream of Forestville, several houses are situated along the West West Branch Schuylkill River. As shown on Plate 1, these houses are about 1/4 mile south of Phoenix Park. The river flows through the community of Llewellyn, 3.7 miles downstream from the dam, and crosses U.S. Route 209. The downstream conditions indicate that a high hazard classification is warranted for Crystal Dam.

f. Spillway Adequacy.

(1) For Case I, the spillway of Crystal Dam will pass the PMF without overtopping the dam. For Case II, the spillway will not pass the PMF without overtopping the dam. One-half the PMF peak inflow for Case II is 3,780 cfs and is greater than the spillway capacity. A check of the surcharge storage effect of Crystal Dam shows that the surcharge storage available is insufficient to contain an inflow with a peak flow of 3,780 cfs without overtopping the dam (Appendix C).

(2) The maximum tailwater before overtopping of the dam is estimated to be Elevation 1204. At maximum pool elevation, there is a difference of about 24 feet between headwater and tailwater. If Crystal Dam should fail due to overtopping, the hazard to loss of life downstream from the dam will be significantly increased from that which would exist just prior to overtopping.

(3) The Case I analysis shows that the spillway of Crystal Dam might pass the PMF without overtopping the dam. Based on OCE criteria as outlined in Paragraph 5.1a.(2), the spillway capacity of Crystal Dam would be rated as adequate. However, the Case I analysis is very preliminary in nature and cannot be used to rate the adequacy of the spillway. Until a detailed study is performed, Case II must be used to rate the spillway. Based on established OCE criteria as outlined in

Paragraph 5.1a.(2), the spillway capacity of Crystal Dam is rated as seriously inadequate. Considering the effects of the surcharge storage of 80 acre-feet, the spillway discharge capacity of 2,680 cfs can accommodate a flood with a peak inflow of 2,770 cfs for a storm of the same duration as the PMF. This is 37 percent of the PMF peak inflow.

(4) If the low area of the top of embankment were to be brought up to grade, which would be a relatively minor maintenance task, the spillway capacity would be increased to 4,510 cfs. This would permit the accommodation of a flood with a peak inflow of approximately 4,640 cfs, or 61 percent of the Crystal Dam PMF peak flow. The spillway capacity of Crystal Dam would then be rated as inadequate instead of seriously inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Crystal Dam resulted in a number of observations relevant to structural stability. These observations are listed herein for the various features.

(2) Embankment. Three wet areas were observed along the downstream toe of the embankment. The detailed descriptions and evaluations of the wet areas are in Paragraphs 3.1b. and 3.2a., respectively.

b. Design and Construction Data. No records of design data or stability computations were available for review. The plans show the upstream slope to be 1V on 3.5H and the downstream slope to be 1V on 2H. Surveys made for this inspection showed the downstream slope to be about 1V on 1.9H, which is a minor deviation from the plans. The downstream slope is steeper than would be used in current practice unless an extensive drainage system were provided. However, evaluation of the design and construction procedures that were used indicate that the stability of the embankment is probably adequate under existing conditions. The following factors contribute to the stability of the embankment: a deep cutoff trench was excavated into rock; there is a rockfill zone downstream; earthfill was used selectively and was sprinkled and compacted; and satisfactory provisions were made for springs encountered during construction.

c. Operating Records. There is no evidence that any stability problems have occurred for the dam during its operational history of 80 years. As far as can be determined, conditions at the site have been stable since the construction of the dam.

d. Post-Construction Changes. There have been no significant structural modifications of the dam since it was constructed in 1898.

e. Seismic Stability. Crystal Dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading. However, the theoretical static stability of Crystal Dam is not known.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the visual inspection, available records, calculations and past operational performance, Crystal Dam is judged to be in good condition. However, deficiencies of varying degree of importance were noted. A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiencies
Embankment:	
Top of embankment	Lower than design elevation.
Upstream slope	Light brush.
Downstream slope	Light brush.
Downstream toe	Three wet areas.
Left Spillway:	
Discharge channel	Bridge support in channel; debris, brush, and trees.
Right Spillway:	
Discharge channel	Brush and trees.
Outlet Works:	
Valves	Rusted.
Outlet channel	Unprotected pipeline crosses channel.

(2) The hydrology of the watershed of Crystal Dam has been significantly altered by strip mines. Available mapping is not adequate for the purpose of determining the effective drainage area. In addition, inflow into the reservoir is subject to numerous hydraulic controls. A detailed watershed study is not within the scope of this report. However, during this inspection an attempt was made to consider the possible effects of the modifications to the watershed. Accordingly, two cases were investigated. Case I analyzed the hydrology of the existing watershed to the extent that was possible using very limited information. Case II analyzed the hydrology of the original watershed

as if it were in a natural condition. Neither case is believed to accurately reflect actual conditions. Because Case II is a more conservative approach, it was used to evaluate spillway adequacy. Based on OCE criteria, as outlined in Paragraph 5.1a.(2), the spillway capacity of Crystal Dam is rated as seriously inadequate. The existing spillway can accommodate a flood with a peak inflow of 37 percent of the PMF peak inflow for the original Crystal Dam watershed. If the low areas of the top of the embankment were brought up to grade, the existing spillway could accommodate a flood with a peak inflow of 61 percent of the PMF peak inflow for the original Crystal Dam watershed. Furthermore, the results of the Case I analysis indicate that more detailed study of the watershed could change the rating of the spillway to adequate.

(3) Although no stability analyses are available for the embankment, the combination of exterior lines, design features, construction information, and performance history indicate that the stability of the embankment is probably adequate under existing conditions.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented as soon as practical or in a timely manner, as noted.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations will be required.

7.2 Recommendations and Remedial Measures.

a. In view of the concern for safety of Crystal Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Restore embankment to original design elevation.

(2) Perform a detailed mapping and hydrologic study of the watershed to more accurately ascertain the required spillway capacity of Crystal Dam. The study should include a determination of all contributing drainage areas, determination of critical features for inflow control, hydraulic capacities of all outflow facilities, and the effects of regulation at the diversion structure.

(3) Replace or modify the pipe bridge across the left spillway so that no supports are in the spillway discharge channel.

(4) Fill the excavated area between the diversion channel and the channel of the West West Branch Schuylkill River.

(5) Develop a detailed emergency operation and warning system for Crystal Dam.

b. In order to correct operational, maintenance and repair deficiencies, and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Clear spillway discharge channels of brush and trees.

(2) Clean out the small channel that drains the wet area along the toe of the dam near the left abutment so the wet area is properly drained. Install a weir to measure outflow, monitor the area visually, and maintain records.

(3) Make provisions, such as drains or ditches, to drain the wet area along the toe 50 feet right of the gatehouse. Measure outflow and maintain records. If conditions worsen they should be thoroughly studied and, if necessary, remedial action should be taken.

(4) Visually monitor wet area along toe 30 feet left of gatehouse.

(5) Remove brush on embankment slopes.

(6) Maintain valves and operate them on a regular basis.

(7) Make provisions for operating blowoff without damaging the waterline in the outlet channel.

c. In addition, the following operational measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Crystal Dam during periods of unusually heavy rains.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

(3) Implement an annual inspection program of all project features and maintain inspection records. Special attention should be given to monitoring alterations of any features of the watershed. The effects of any alterations on the hydrology of the watershed should be evaluated.

DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

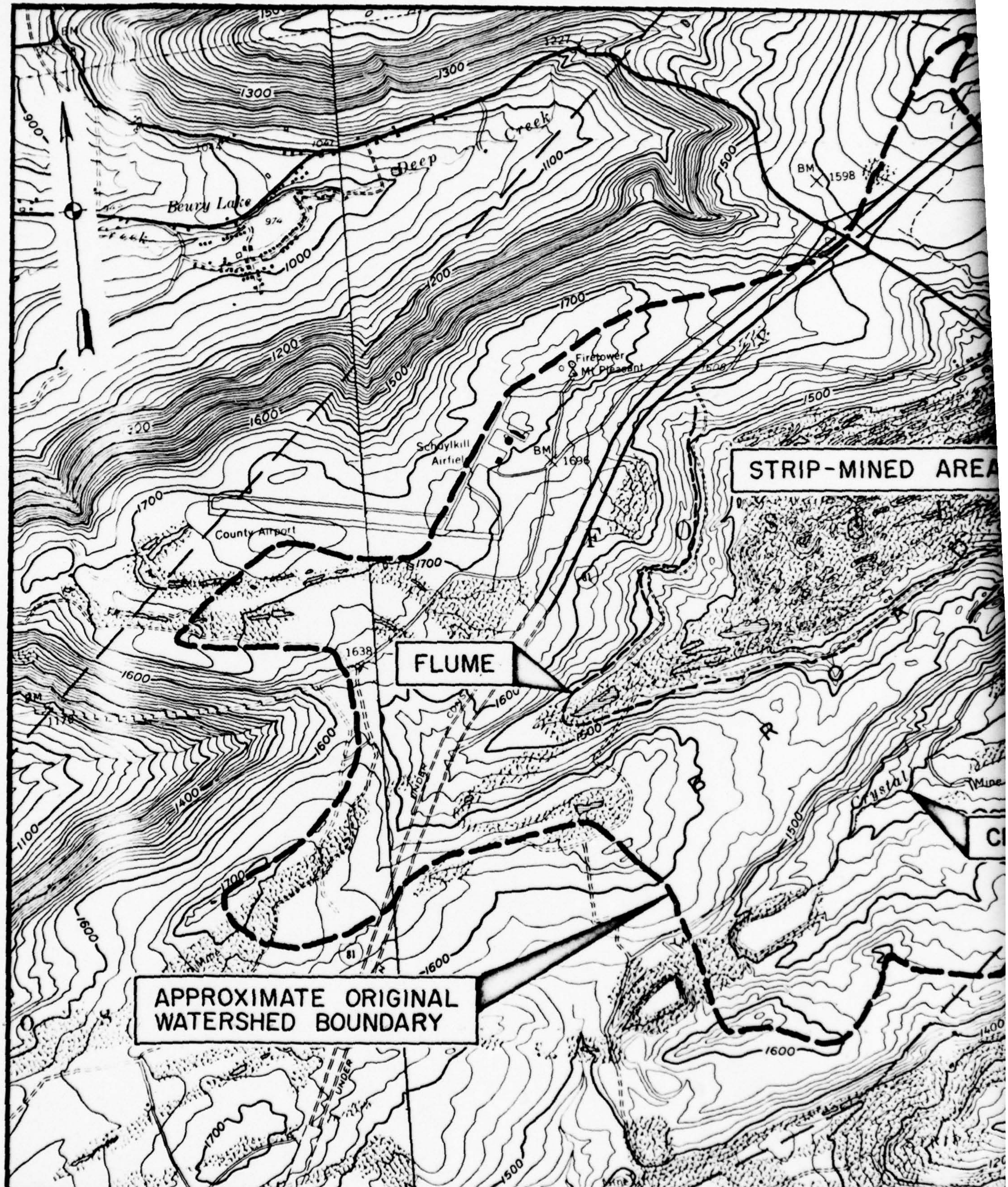
MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

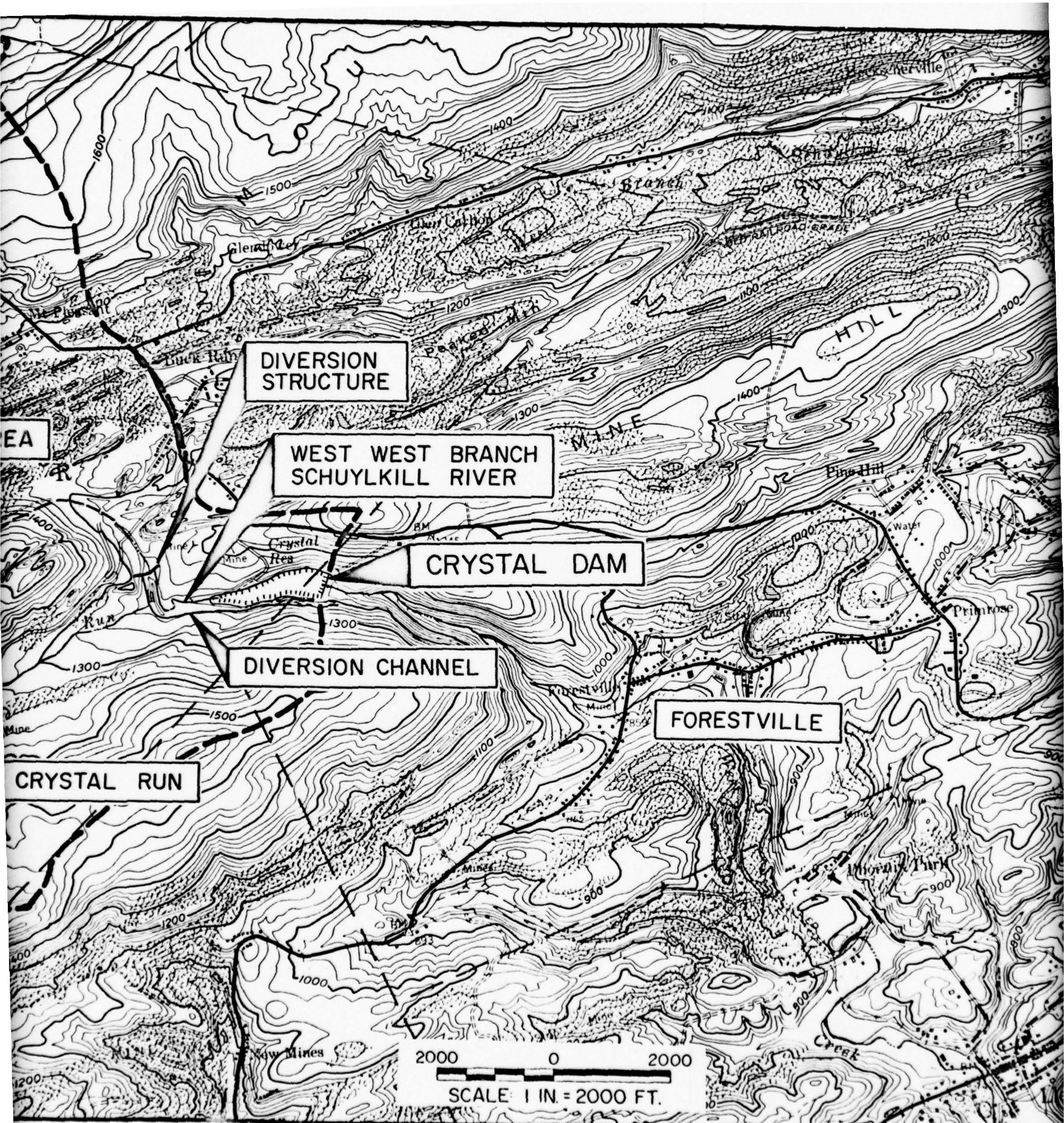
PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

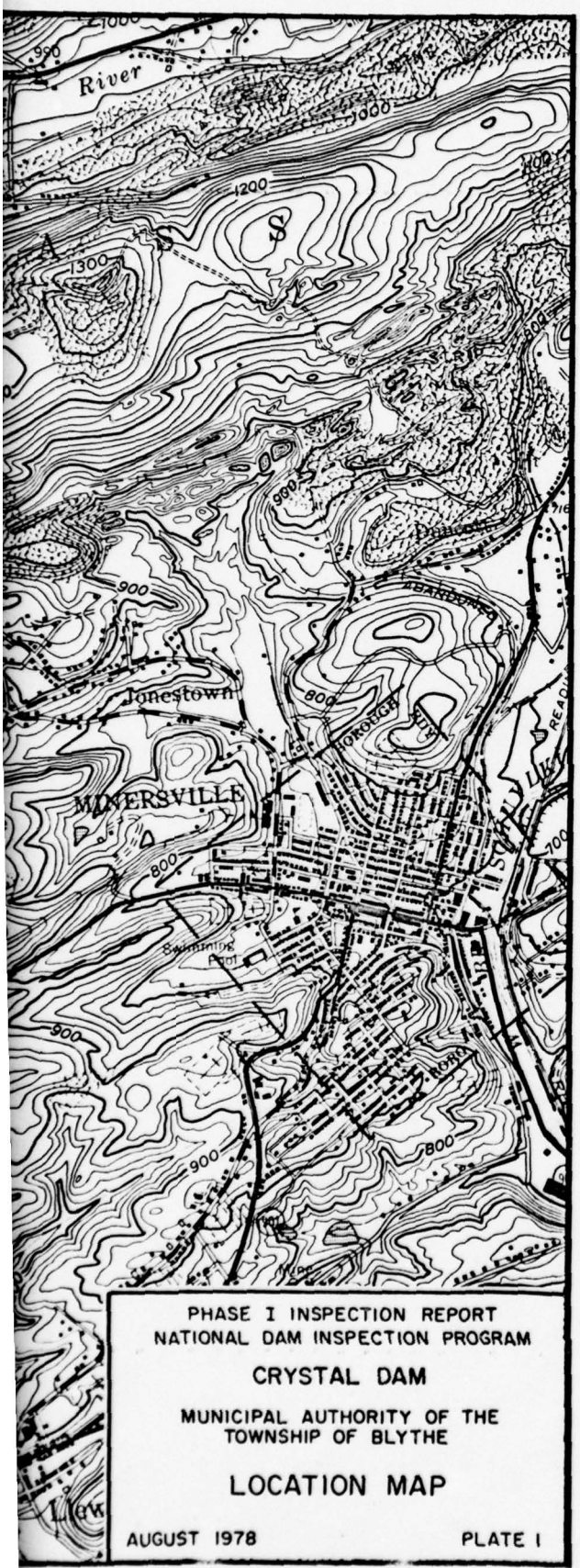
PLATES


STRIP-MINED AREA
FLUME
APPROXIMATE ORIGINAL
WATERSHED BOUNDARY
Deep
Creek
Beury Lake
Firetower
Mt Pleasant
Schuylkill
Airfield
County Airport
Crystal


DIVERSION STRUCTURE
WEST WEST BRANCH SCHUYLKILL RIVER
CRYSTAL DAM
DIVERSION CHANNEL
FORESTVILLE
CRYSTAL RUN
EA
2000 0 2000
SCALE 1 IN. = 2000 FT.

1

2.



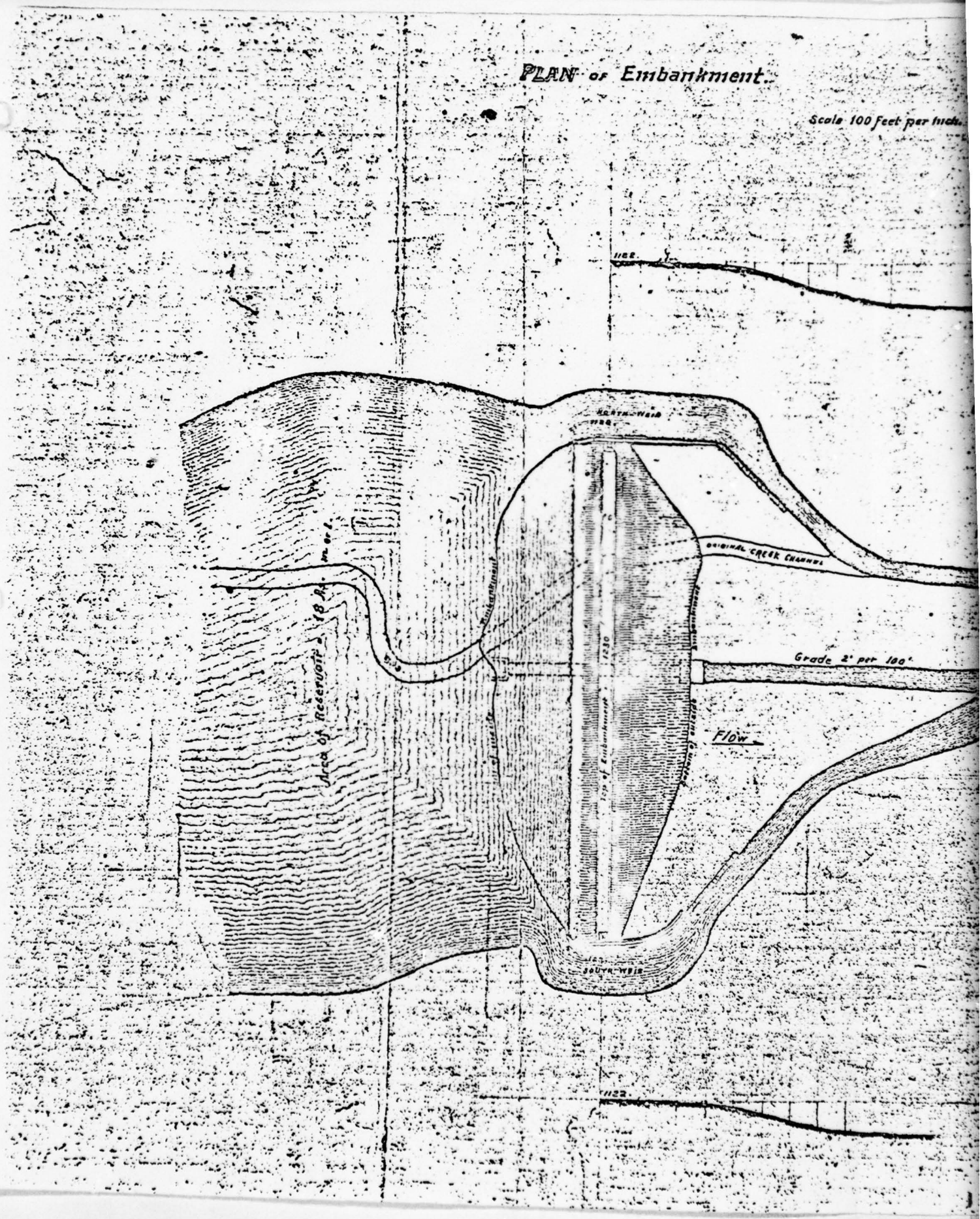
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

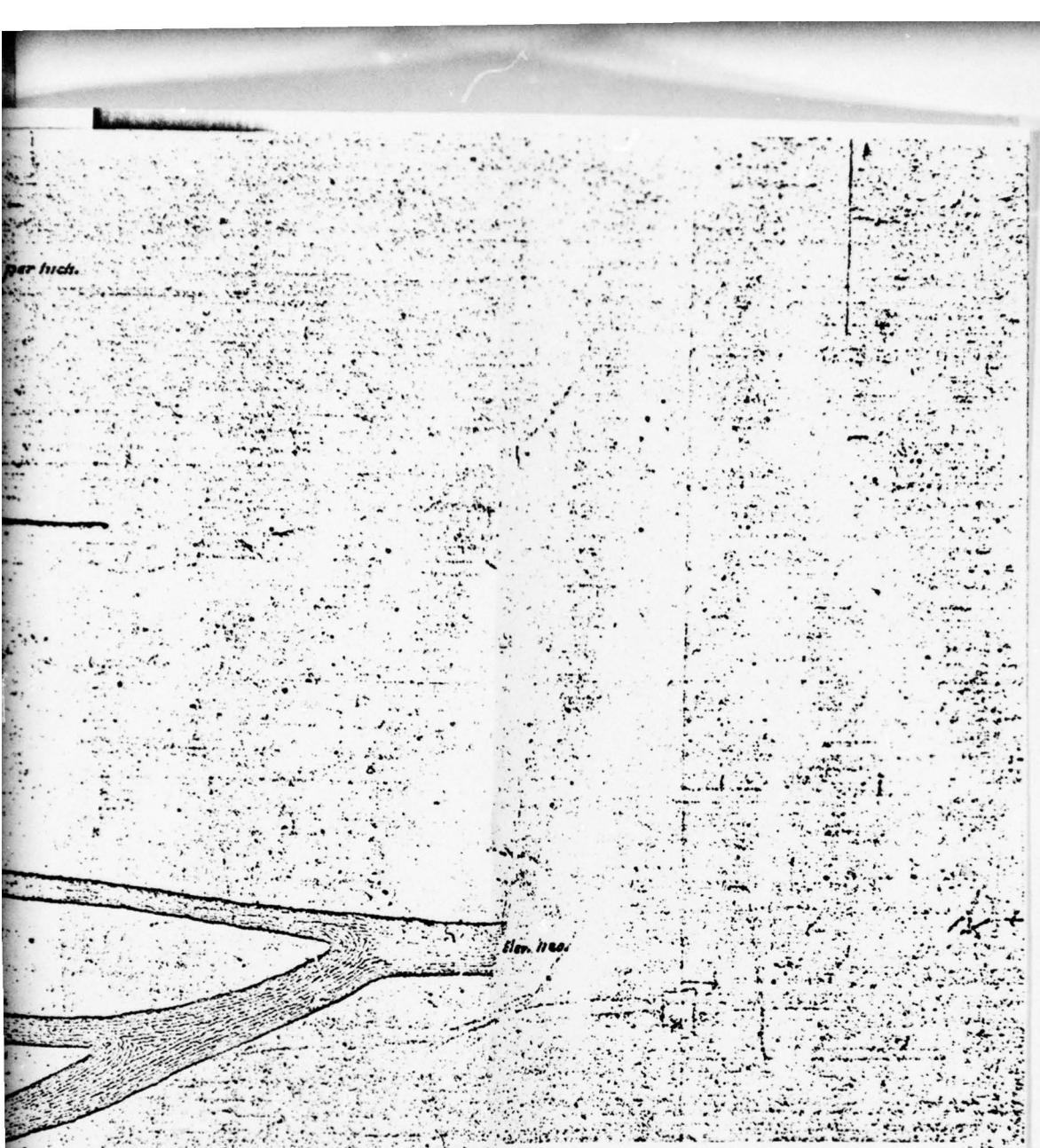
CRYSTAL DAM

MUNICIPAL AUTHORITY OF THE
TOWNSHIP OF BLYTHE

LOCATION MAP

AUGUST 1978 PLATE 1


PLAN of Embankment.
Scale 100 feet per inch.
1122
NORTH-WEST
1122
ORIGINAL CREEK CHANNEL
Grade 2' per 100'
FLOW
Area of Reservoir = 18 Ac.
Top of Embankment
1230
SOUTH-WEST
1122



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CRYSTAL DAM

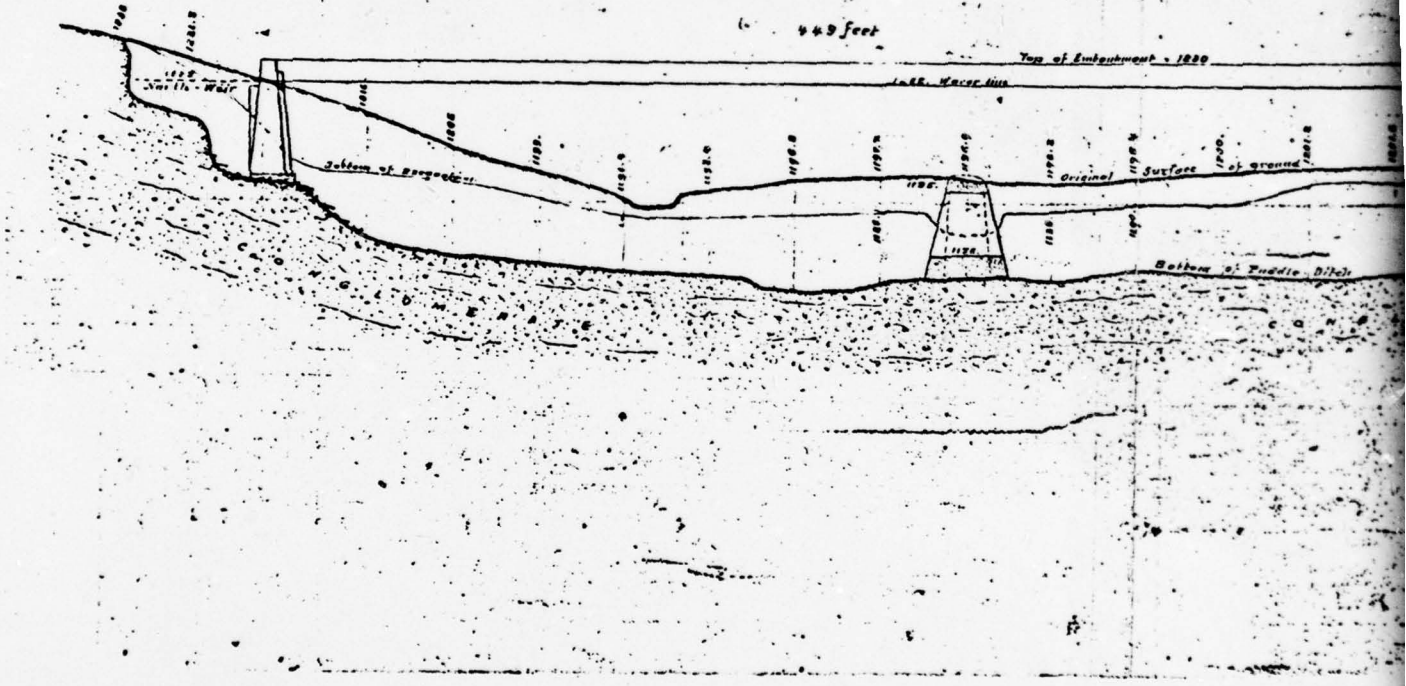
MUNICIPAL AUTHORITY OF THE
TOWNSHIP OF BLYTHE

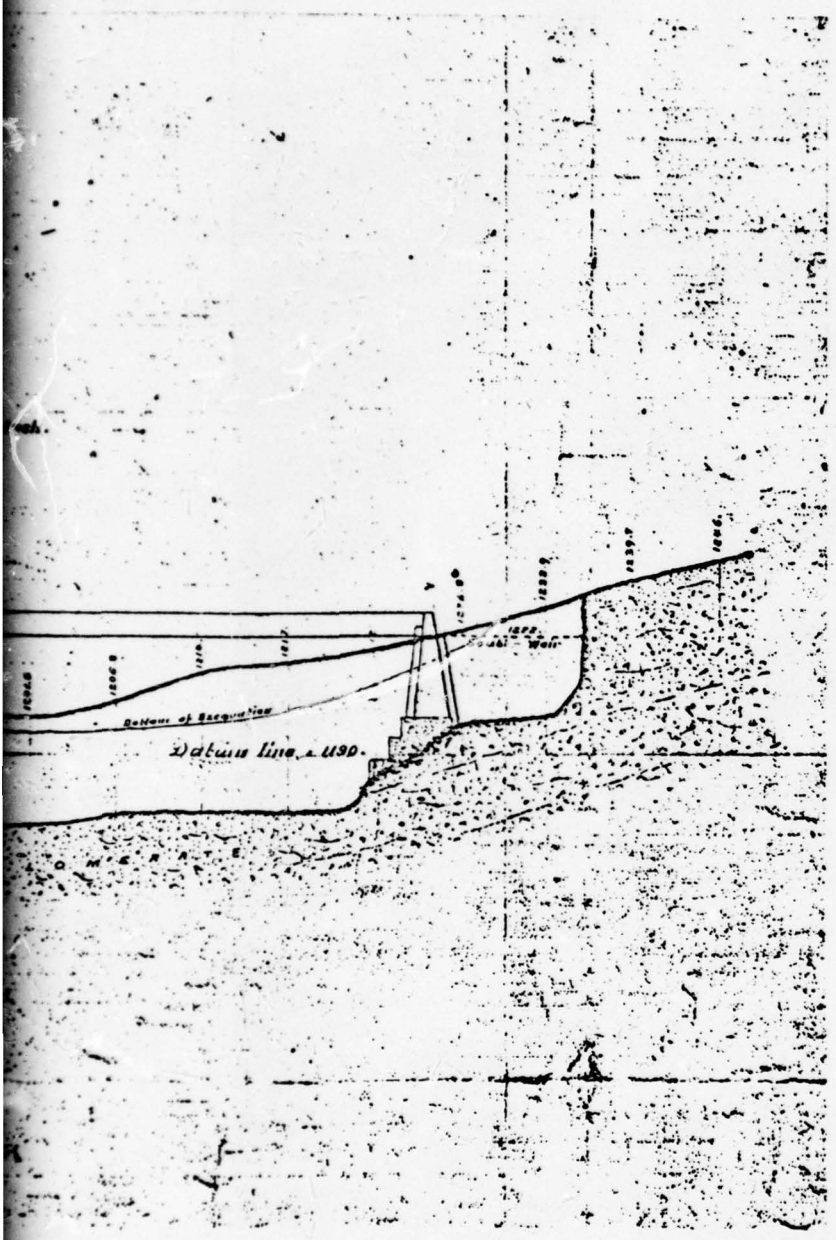
GENERAL PLAN
OF ORIGINAL FEATURES

AUGUST 1978 PLATE 2

LONGITUDINAL SECTION of Excavation.

Scale 50 feet per inch





PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

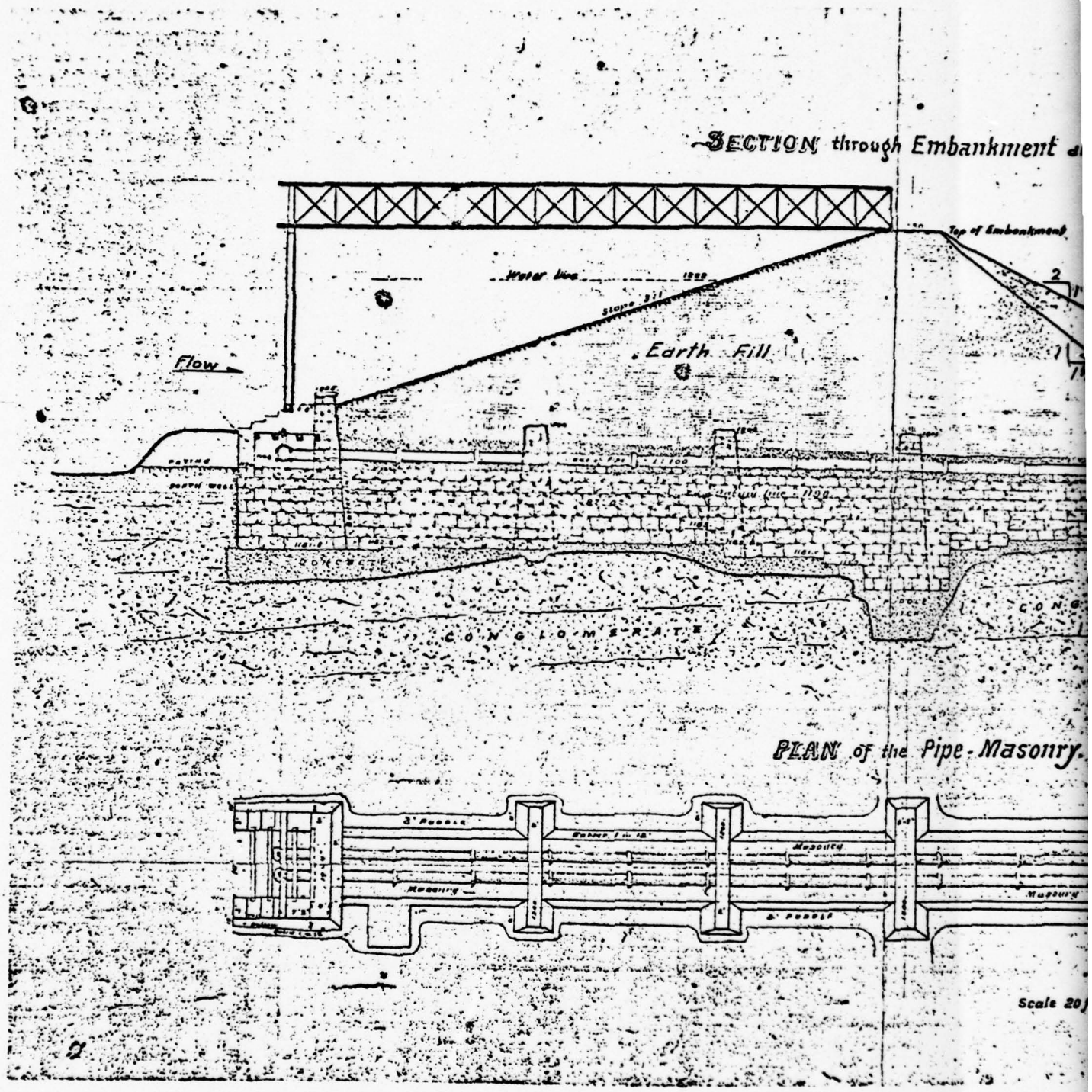
CRYSTAL DAM

MUNICIPAL AUTHORITY OF THE
TOWNSHIP OF BLYTHE

PROFILE ALONG AXIS OF DAM

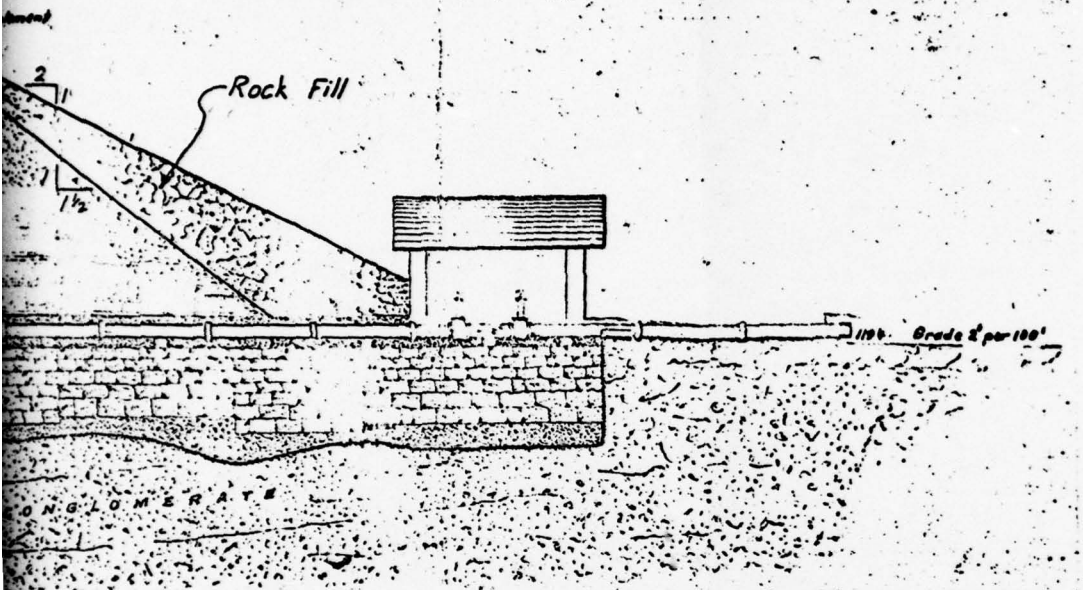
AUGUST 1978 PLATE 3

2

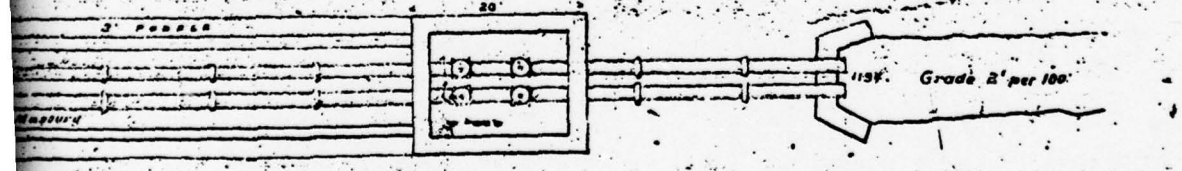

SECTION through Embankment
Top of Embankment
Water line
Slope
Earth Fill
Flow
CONGLOMERATE
PLAN of the Pipe-Masonry.
Masonry
Scale 20

nt and Pipe-Masonry.

Scale 20 Feet per Inch.



onry.



ale 20 Feet per Inch.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CRYSTAL DAM

MUNICIPAL AUTHORITY OF THE
TOWNSHIP OF BLYTHE

EMBANKMENT SECTION
AT OUTLET WORKS

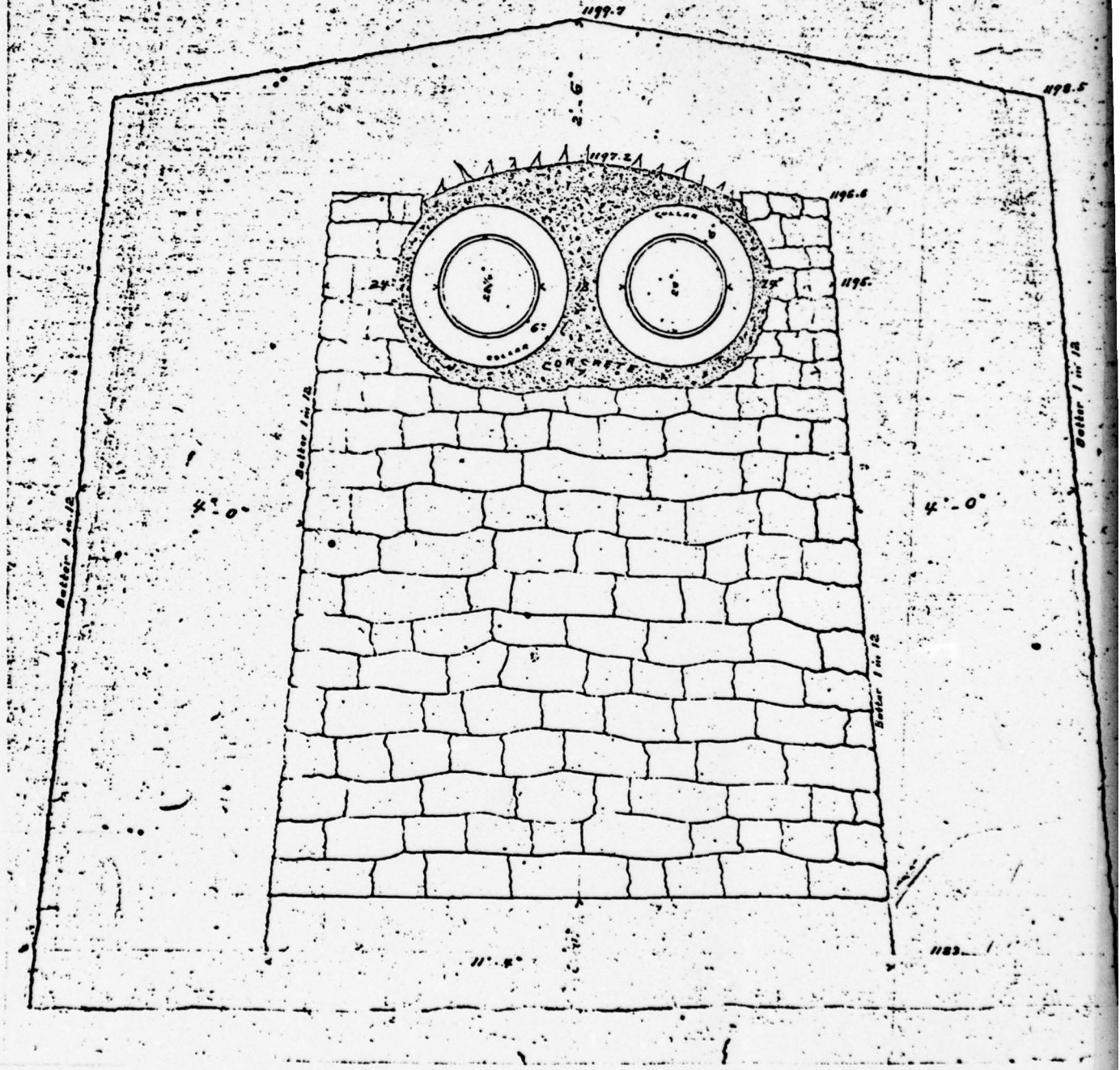
AUGUST 1978 PLATE 4

2

SECTION through Pipe Wall.

SCALE 2 FEET PER INCH.

Pottsville, December 1897.



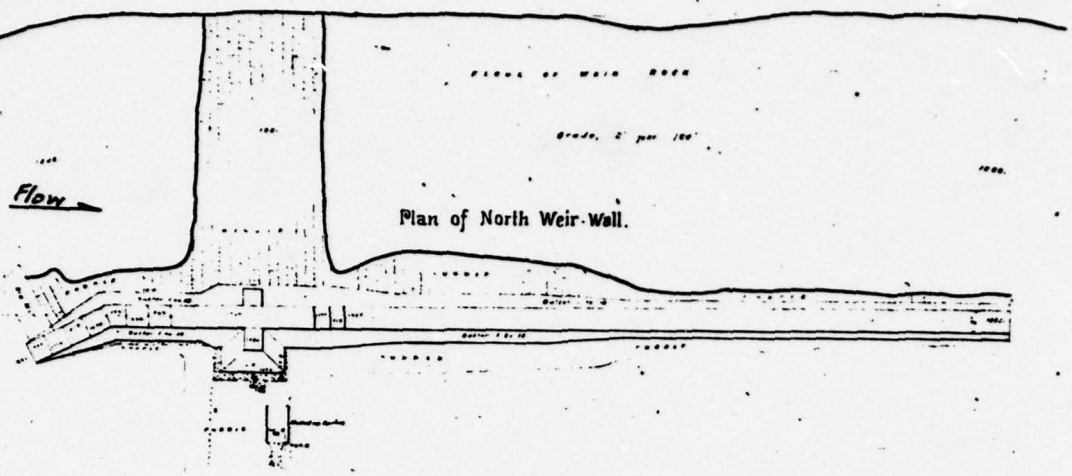
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CRYSTAL DAM

MUNICIPAL AUTHORITY OF THE
TOWNSHIP OF BLYTHE

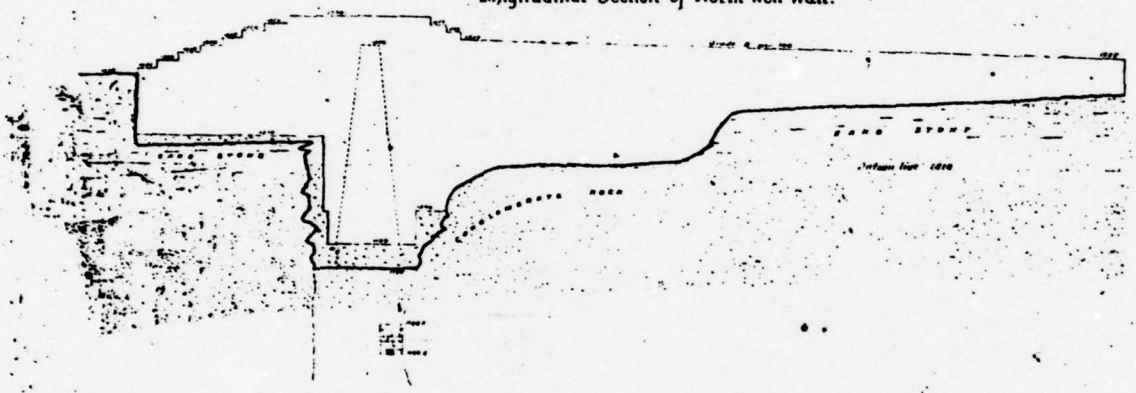
OUTLET WORKS SECTION

AUGUST 1978 PLATE 5

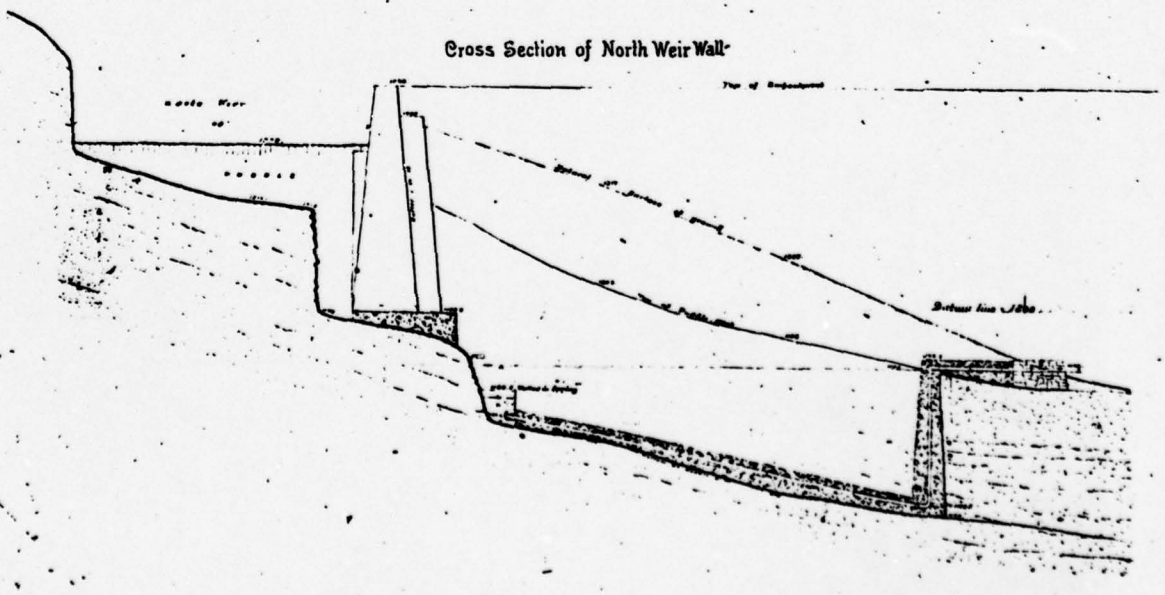


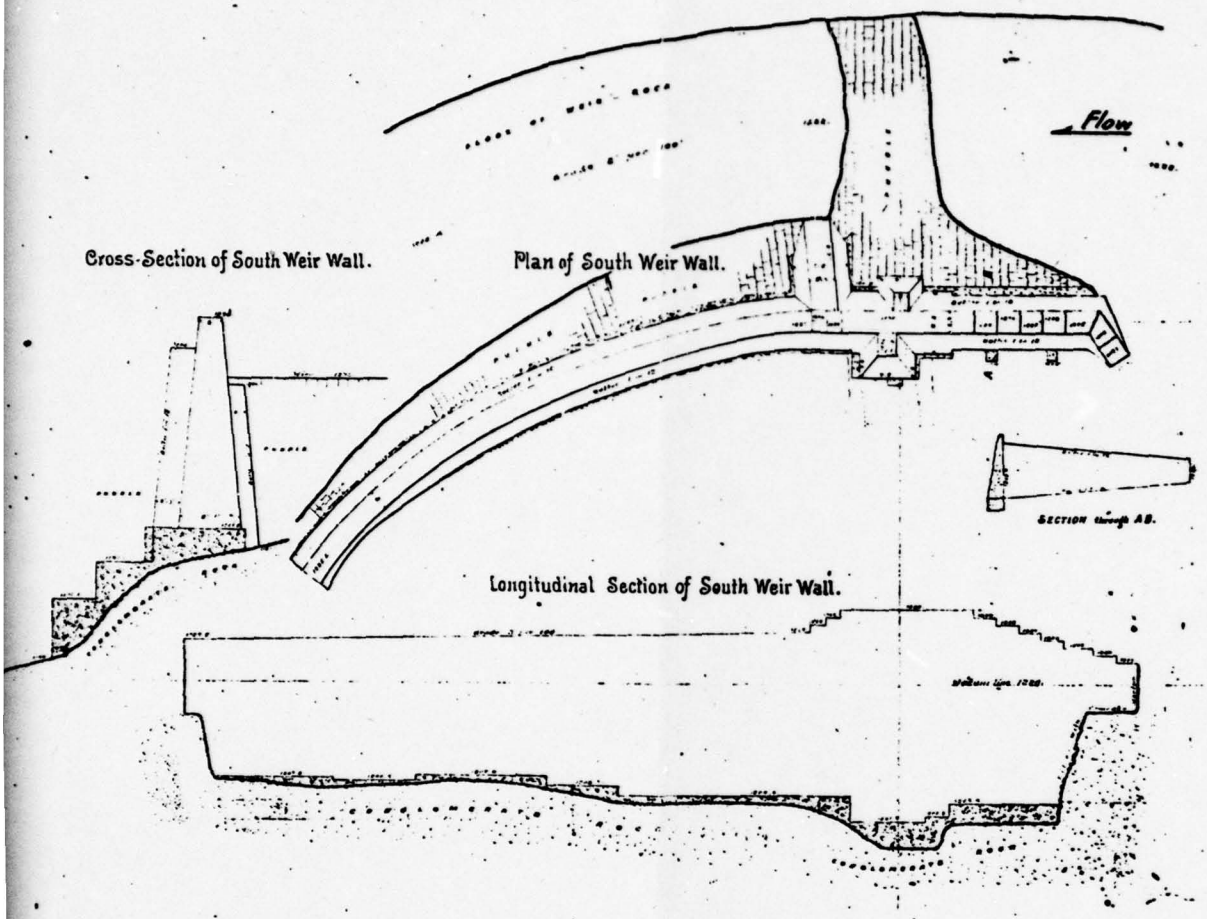
Plan of North Weir-Wall.

Longitudinal Section of North Weir Wall.



Cross Section of North Weir Wall.





CRYSTAL WATER CO.

Plan and Sections of South and North Weir Walls

OF THE

WEST WEST BRANCH RESERVOIR.

SCALE 10 FEET PER INCH.

Pottsville, January 1898.

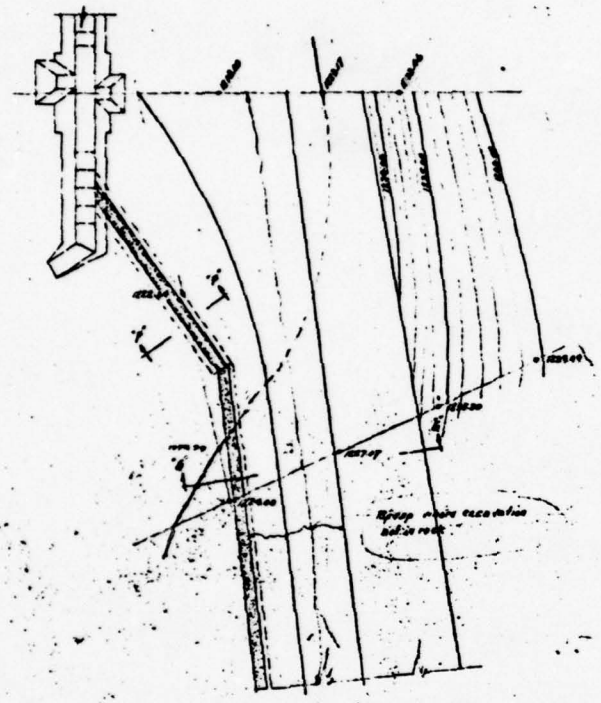
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CRYSTAL DAM

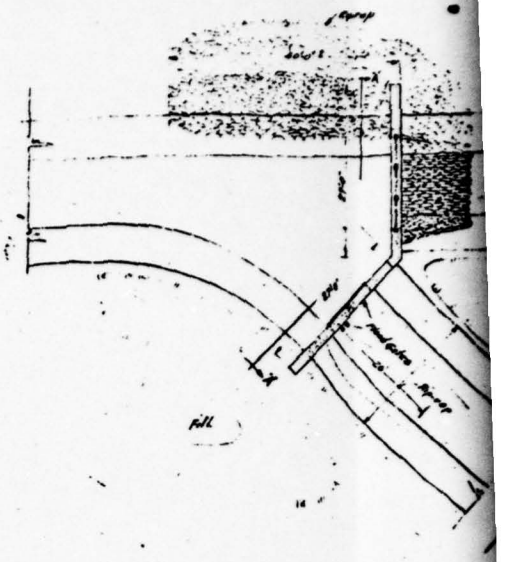
MUNICIPAL AUTHORITY OF THE
TOWNSHIP OF BLYTHE

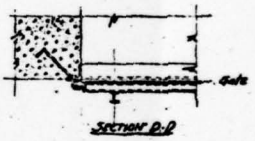
DETAILS OF
ORIGINAL SPILLWAYS

AUGUST 1978 PLATE 6

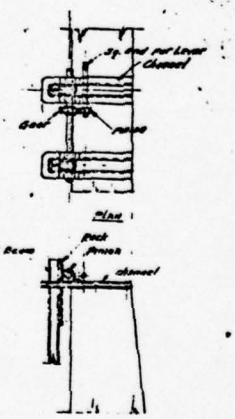


PLAN (REAR & WALL)
Scale 1"=10'





SECTION D-D



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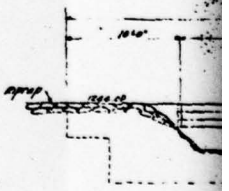
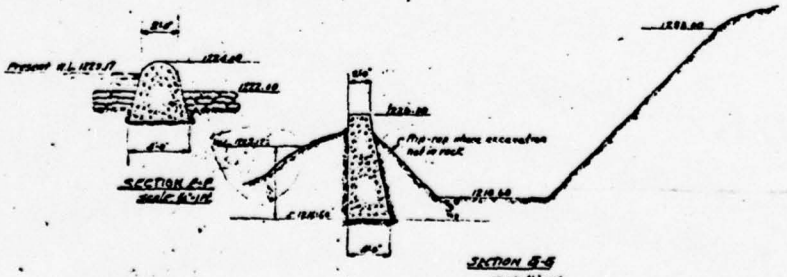
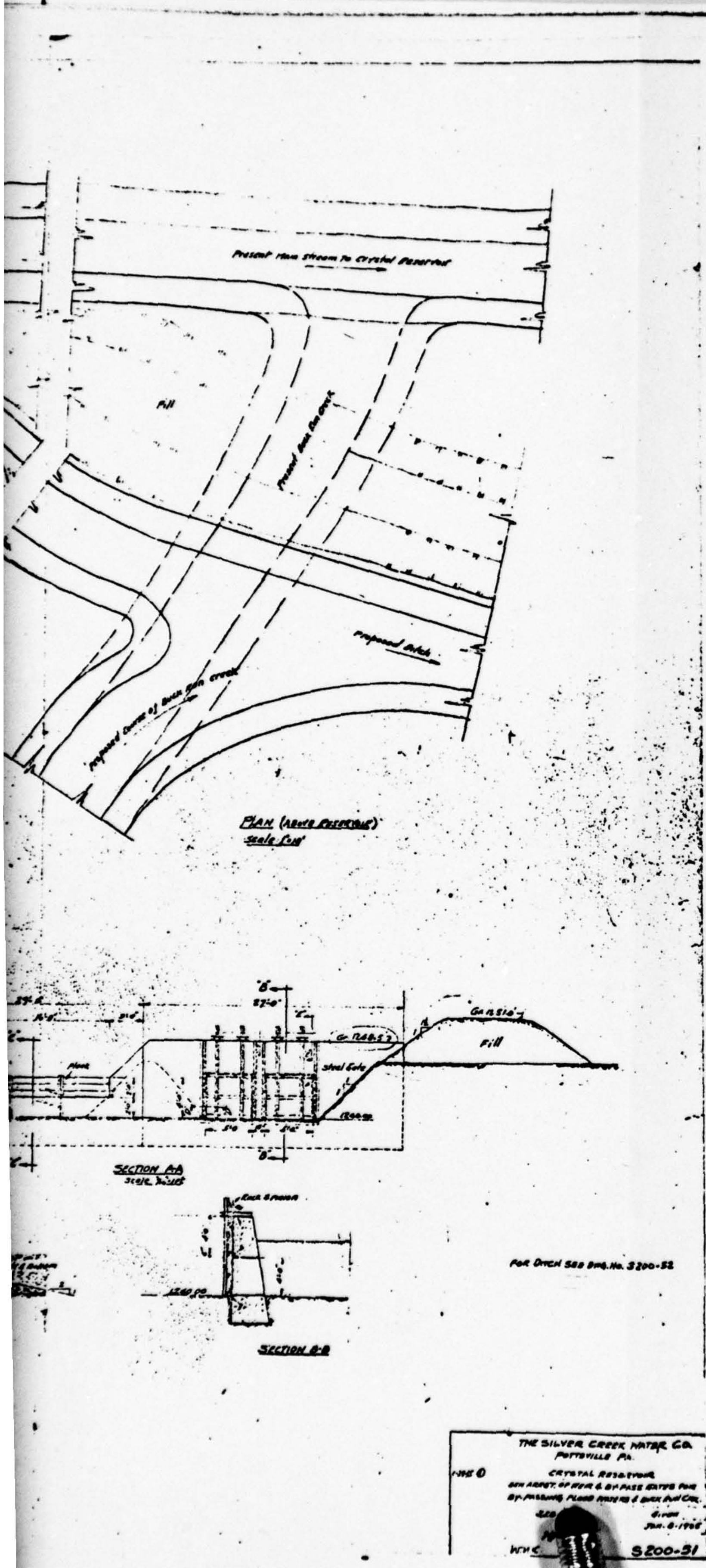




SECTION F-F
Scale 1/8"

SECTION G-G
Scale 1/8"=1'



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CRYSTAL DAM

MUNICIPAL AUTHORITY OF THE
TOWNSHIP OF BLYTHE

DETAILS OF
DIVERSION WORKS

AUGUST 1978 PLATE 7

DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Crystal Dam

NDS ID NO.: PA-00677 DER ID NO.: 54-15

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	Construction drawings available.
REGIONAL VICINITY MAP	Project is shown on USGS Quadrangle Sheet Minersville, Pennsylvania; N4037.5-W7615/7.5; 1955; Photorevised 1969.
CONSTRUCTION HISTORY	Constructed 1897-1898 by Crystal Water Company. Modified 1927 and 1935.
TYPICAL SECTIONS OF DAM	Available.
OUTLETS: Plan Details Constraints Discharge Ratings	Plan and details available. No discharge ratings.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Records for storm of 3/11/36 - 3/22/36.
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	None.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	None.
POSTCONSTRUCTION SURVEYS OF DAM	None.

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Unknown.
MONITORING SYSTEMS	None.
MODIFICATIONS	1927: Both spillway crests raised 1 foot. 1935: Constructed diversion channel around dam and converted right spillway to side channel spillway.
HIGH POOL RECORDS	None.
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	1914: General report by Pennsylvania Water Supply Commission on construction, hydraulics, and condition. 1935: Permit application report for diversion channel.
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	None.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	None.
SPILLWAY: Plan Sections Details	Available.
OPERATING EQUIPMENT: Plans Details	Available.
PREVIOUS INSPECTIONS Dates Deficiencies (Continued on Sheet A-5)	1919: No deficiencies. 1923: Crest of dam 1 foot low; small amount of seepage. 1924: No deficiencies (inspection by Owner). 1927: Seepage at toe at left end; brush in right spillway. 1931: Seepage at left end; rounded concrete crest added to spillways; top dam 0.8 foot low. 1934: Seepage 50 feet right of gatehouse 15 feet from toe; seepage 100 feet left of gatehouse at toe; trickle from drains at left end. 1935: Leakage; diversion work in progress. 1938: Swampy area 50 feet right of gatehouse; small stream under 8-inch pipe to right of blowoff; seepage 50 feet left of gatehouse; diversion channel irregular.

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (Continued from Sheet A-4)	1940: Small spring at toe at left hillside; top of dam 9 inches low; riprap displaced at water level. 1942: Same as 1940 except crest of auxiliary spillway deteriorated. 1946: Same as 1942 plus blowoff leaking. 1962: Brush on crest and upstream slope; swampy at abutments; right spillway disintegrated; brush on spillways. 1971: Damp at left abutment and at center.

CHECKLIST

ENGINEERING DATA

HYDROLOGY AND HYDRAULICS

NAME OF DAM: Crystal Dam NDS ID NO.: PA-00677 DER ID NO.: 54-15

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): Elevation 1224.1

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Elevation 1228.5

ELEVATION MAXIMUM DESIGN POOL: Elevation 1230.0 (Design Top of Dam)

ELEVATION TOP DAM: Elevation 1228.5.

SPILLWAY CREST:
- a. Elevation: Left: Elevation 1224.1; Right: Elevation 1224.6.
- b. Type Left: rounded crest; Right: rounded crest side channel.
- c. Width Not Applicable.
- d. Length Left: 38 feet; Right: 90 feet.
- e. Location Spillover Left and right abutments.
- f. Number and Type of Gates None.

OUTLET WORKS:
- a. Type One 20-inch water supply and one 20-inch blowoff.
- b. Location Center of embankment.
- c. Entrance Inverts Elevation 1193.0.
- d. Exit Inverts Elevation 1192.2.
- e. Emergency Draindown Facilities One 20-inch blowoff.

HYDROMETEOROLOGICAL GAGES:
- a. Type None.
- b. Location None.
- c. Records None.

MAXIMUM NONDAMAGING DISCHARGE: Unknown.

DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Crystal Dam County: Schuylkill State: Pennsylvania

NDS ID No.: PA-00677 DER ID No.: 54-15

Type of Dam: Earthfill Hazard Category: High

Date(s) Inspection: 29 June 1978 Weather: Clear Temperature: 85°

Pool Elevation at Time of Inspection: 1221.6 msl/Tailwater at Time of Inspection: 1192.0 msl

Inspection Personnel:

D. Wilson (GFCC)	S. Dobies (Blythe Twp.)	
D. Wolf (GFCC)	L. Schad (Blythe Twp.)	
D. Ebersole (GFCC)		

D. Wilson (GFCC) Recorder

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	None.	
CREST ALIGNMENT: Vertical Horizontal	Horizontal: no irregularities. Vertical: Elevation varies from El. 1228.5 to El. 1229.5.	Design elevation for top of dam is El. 1230.0.
RIPRAP FAILURES	1. Downstream slope: some weeds and light brush. 2. Upstream slope: some light brush.	1. Stone sound; placement uniform; 6-12" size. 2. Brush cut recently; riprap hand-placed; good condition.

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	No abnormalities.	
ANY NOTICEABLE SEEPAGE (Continued on Sheet B-10)	1. Swampy area at toe 100 feet left of gatehouse; 5 gpm clear flow. 2. Swampy area 30 feet left of gatehouse.	1. Flow collected by overgrown channel. 2. No flow; slight standing water; not excessively soft.
STAFF GAGE AND RECORDER	None.	
DRAINS	None visible.	1914 Report by Water Supply Commission describes two drains.

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not applicable.	
INTAKE STRUCTURE	Submerged.	Could not inspect.
OUTLET STRUCTURE	Gatehouse at downstream toe embankment. Two non-rising stem gate valves on each 20-inch line.	Valve casings badly rusted; not opened in 12 years; opened blow-off partially for inspection.
OUTLET CHANNEL	Small channel with low masonry walls; meter house is in channel; 8-inch pressure line in channel.	Full opening of blowoff might damage 8-inch pressure line; channel overgrown with weeds.
EMERGENCY GATE	No access anymore to valves at upstream end.	

UNGATED SPILLWAY (Left Spillway)

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	No deficiencies.	
APPROACH CHANNEL	No operating constraints.	
DISCHARGE CHANNEL	Growth of weeds and brush; some small trees.	
BRIDGE AND PIERS	Pressure pipe bridge support at center of discharge channel 35 feet downstream from weir.	

UNGATED SPILLWAY (Right Spillway)

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Small area of disintegration at junction of main and auxiliary section.	Concrete good otherwise.
APPROACH CHANNEL	No operating constraints.	Some light brush but not significant.
DISCHARGE CHANNEL	Discharges into diversion channel. Some light brush and occasional trees.	
BRIDGE AND PIERS	None.	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	No sign of instability.	Slopes around most of reservoir about 1V on 2H.
SEDIMENTATION	Some history of sedimentation before diversion channel constructed.	
WATERSHED DESCRIPTION	20% owned by Water Authority; 80% owned by mining companies.	Portions are strip-mined.

DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	None.	
SLOPES	No apparent erosion.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	About 10 low-lying houses in Forestville; additional ones scattered downstream.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEEPAGE (Continued from Sheet B-3)	3. Swampy area 50 feet right of gatehouse; slight standing water; no flow.	3. Lush vegetation extends to gatehouse.

DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

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APPENDIX C

HYDROLOGY AND HYDRAULICS

Classification - ref. recomended guidelines

The hazard classification is high since the downstream population is 268. - ref. Recommended Guidelines for Safety Inspection of Dams. p D-9

The size classification is small since the height of the dam is 38 ft. - ref. Recommended Guidelines for Safety Inspection of Dams. p D-8

Spillway Design Flood

The spillway design flood should be ½ PMF to PMF for a high hazard dam of small size - ref. same, p D-12.

Note: SDF used is the PMF, since 38' is close to the class limit of 40'.

Hydrologic and Hydraulic Analysis

Reference - Phase I Procedure Package

II.A. Crystal Lake Dam is not ideally situated as shown on Plate 1. There are no dams upstream, but extensive strip mining has modified the characteristics of the drainage area.

1. Strip Mining along the West West Branch Schuylkill River has progressed to the point where there is a 200' deep pit where the river used to be. Flow from some of the undisturbed upstream area, as well as regulated outflow from an abandoned quarry near the Schuylkill County Airfield, is diverted around the upstream end of the pit. There

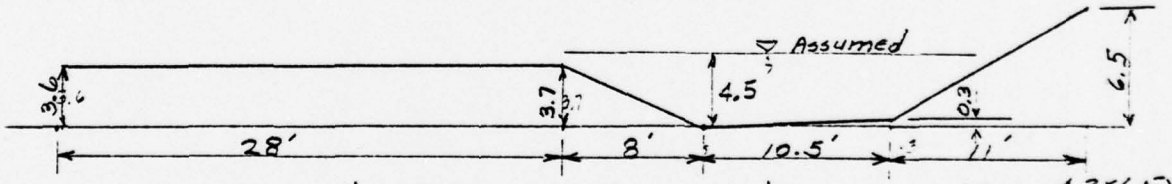
(26"ϕ) overflow
are 5 corrugated metal conduits which are intended to limit the flow in the diversion flume. These are not considered in the H+H analysis because debris outwash under PMF conditions may render them inoperative. The maximum capacity of the diversion flume is the bankfull discharge which is fixed by the elevation of the adjacent access road. A minimum capacity section was surveyed.

Calculate S_o - dist, El., S_o

dist	El.	S_o	
+100	991.8	0.004	
0	991.4	0.009	Avg $S_o = 0.007$
-100'	990.5	0.007	
-200'	989.8		

Calculate Q

Assume: maximum depth at $4\frac{1}{2}$ ft.
$n = 0.030$



$$A = \tfrac{1}{2}(8\times3.7) + 0.8\times8 + 4.2\times10.5 + \tfrac{1}{2}(0.3\times10.5) + \tfrac{1}{2}\left(4.2\times\frac{4.2\times10.5}{11}\right)$$
$$= 14.8 + 6.4 + 44.1 + 1.58 + 5.21$$
$$= 72.1\ ft^2$$

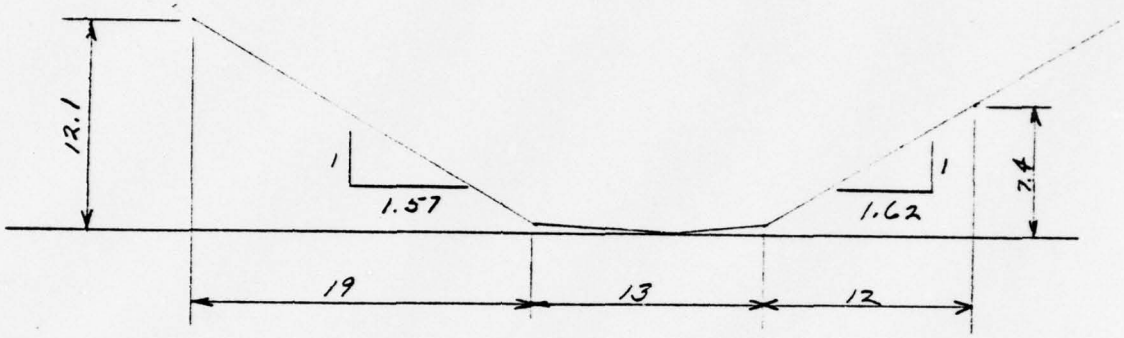
$$P = \sqrt{8^2+3.7^2} + \sqrt{10.5^2+.3^2} + \sqrt{4.2^2+2.48^2} = 8.8+10.5+4.9$$
$$= 24.2'$$

$$Q = \frac{1.486}{0.030}\times72.1\times\left(\frac{72.1}{24.2}\right)^{2/3}(0.007)^{1/2} = \underline{620\ cfs}$$

∴ All flow in excess of 620 cfs from this segment of the watershed will overflow into the strip mine pit.

Diversion Canal Capacity

Assume that the GFCC surveyed x-sect geometry is applicable at the downstream end.



Max water depth @ downstream end is limited by south weir at 6'

1. Calculate $Q_c = \sqrt{gA^3/b} = \sqrt{g \times \frac{[\frac{1}{2}(6 \times 1.57 \times 6) + 6 \times 13 + \frac{1}{2}(6 \times 1.62 \times 6)]^3}{(1.57 \times 6) + 13 + (1.62 \times 6)}}$

$Q_c = \sqrt{g \times 135.4^3 / 32.14} = 1577$ cfs. say 1580 cfs

2. Calculate Y_n

$A = \frac{1}{2}(Y \times 1.57\,Y) + Y \times 13 + \frac{1}{2}(Y \times 1.62\,Y)$; $P = \sqrt{Y^2 + (1.57Y)^2} + 13 + \sqrt{Y^2 + (1.62Y)^2}$
(① ② ③ ⑤ ⑥)

$1580 \times \frac{0.035}{1.486} \times \left(\frac{1}{0.006^{1/2}}\right) = 480 = A \times \left(\frac{A}{P}\right)^{2/3} = AR^{2/3}$

Y	①	②	③	A	⑤	⑥	P	$AR^{2/3}$
8	50.24	104	51.84	206.1	14.9	15.2	43.1	585
7	38.46	91	39.69	169.15	13.03	13.32	39.35	447.2
7.2	40.69	93.6	41.99	176.28	13.40	13.71	40.11	473.0

Say $Y_n = 7.2'$

Develop PMF hydrographs

As per instructions from NAB, the PMF inflow hydrograph for Crystal Run Dam is developed by transposing a previously estimated PMF with a peak of 7200 cfs at 4.8 Mi^2 and adjusting the base so that the runoff volume of the PMF hydrograph is 24". Assume a triangular shaped hydrograph.

PMF peak = $7200 cfs \times \left(\frac{5.1}{4.8}\right)^{0.8} \cong$ 7560 cfs

base = $\left(2 \times 640 \times 5.1 \times 2\right) \div \left(7560 \times \frac{3600}{43560}\right)$ = 20.9 hrs.

Vol = $2 \times 640 \times 5.1$ = 6528 Acre-Ft.

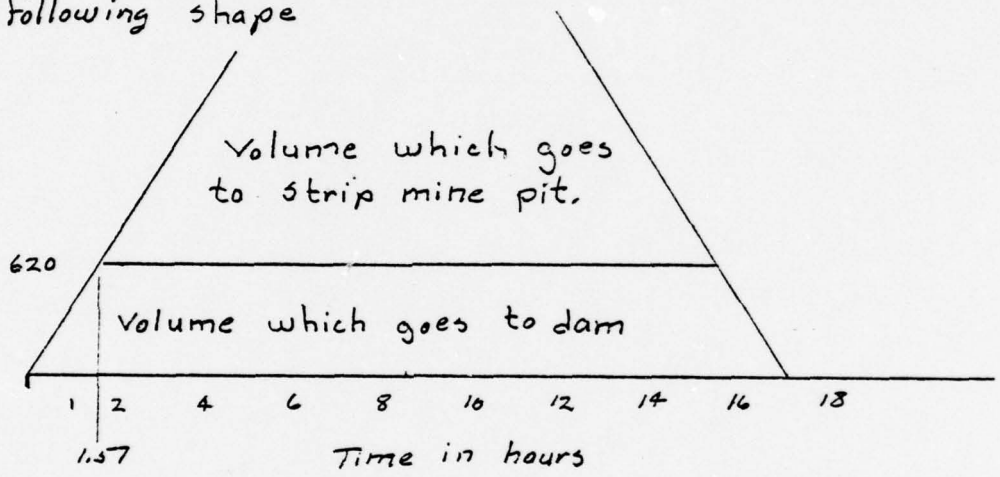
COMPONENT	PEAK $Q_2 = (A_2/A)^{0.8} Q_1$	BASE triangle hyd.	Vol $V_2 = (A_2/A_1) V_1$	Area
Total	7560	20.9	6528	5.1
Flume	3373	17.1	2380	1.86
Crystal Run	3168	16.8	2202	1.72
Strip Mine Area.	2870	16.4	1946	1.52

The hydrologic analysis of this reservoir can be only approximately solved due to the mining activity on the watershed

Case I.

1. The flow diverted around the reservoir by the diversion channel is 1580 cfs.
2. The flow from the flume area is limited to 620 cfs

The flume hydrograph is assumed to have the following shape

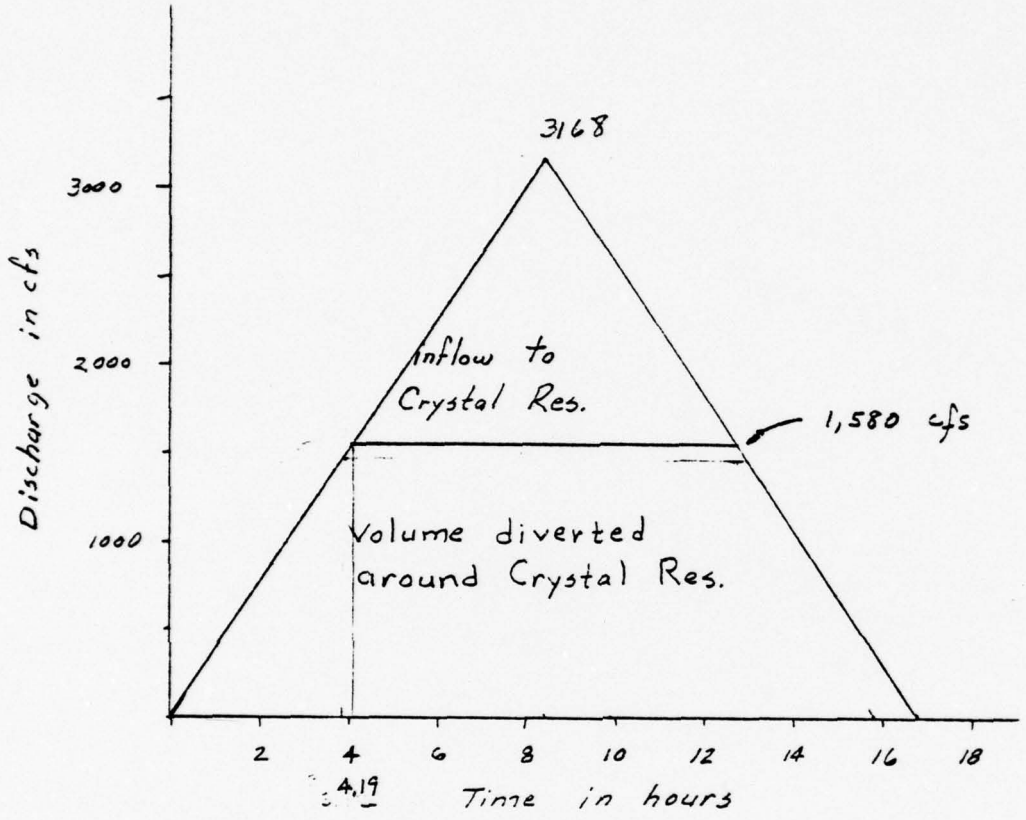


inflow to dam = $\frac{(11.61 + 13.96)}{2}$ hrs × 620 cfs = 9630. cfs-hrs
= 796 acre-ft

inflow to strip mine = overflow from flume + 24" of runoff from strip mine
= (2380 - 796) + 1946 = 3530 Acre-ft.

The estimated size of the strip mine pit is 800' × 2200' = 40 Acres. It is at least 200' deep. ∴ the strip mine pit can store the excess flow from the flume plus the runoff from its own area

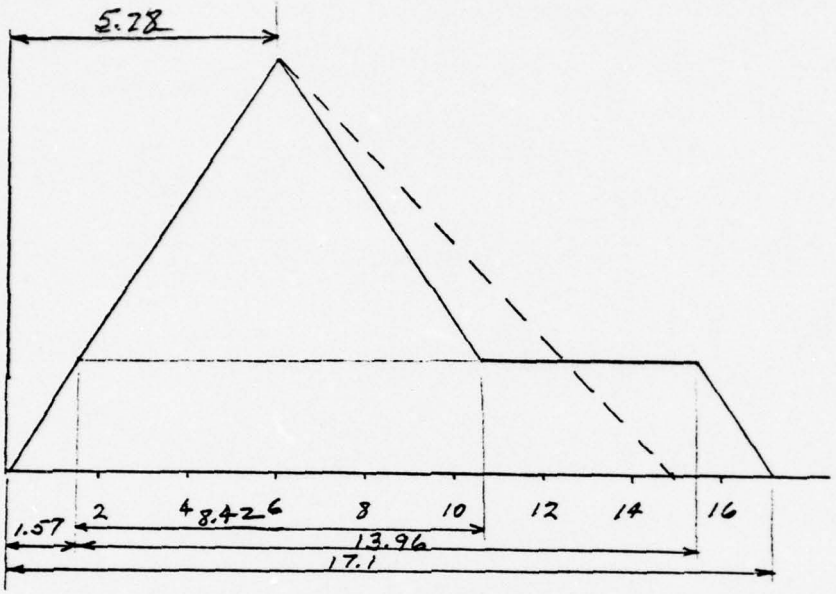
flow from area controlled by the diversion channel can be calculated similarly.



Volume diverted around dam = 19,924 cfs-hrs = 1646 Acre-ft.

Inflow = Q_p = 1588 cfs
b = 8.42 hours
Vol = 6685 cfs-hrs · 552 Acre-Ft

combining the two inflow hydrographs graphically gives:



or, if simplified (dashed recession line)

PMF

Q_p = 2208 say 2210 cfs
b = 14.8 hrs.
Vol = 1348 Acre-Ft.

Determine Spillway Capacity

Top of Dam Elev. 1228.5 (Min), 1230.0 (Design)
Weir Crest Elev. North 1224.1
South - Main 1224.6
Aux 1225.8

North

$$Q_{max} = 3.09 \times 38 \times (1228.5 - 1224.1)^{1.5}$$

$$= 1084 \text{ cfs}$$

South Main

$$Q_{max} = 3.09 \times 35.9 \times (1228.5 - 1224.6)^{3/2}$$

$$= 854 \text{ cfs}$$

Aux

$$Q_{max} = 3.09 \times 54.0 \times (1228.5 - 1225.8)^{3/2}$$

$$= 740 \text{ cfs}$$

Total Spillway capacity = 2678 cfs

This is greater than the Modified PMF inflow which indicates that the spillway capacity would be adequate. Even if the weir coeffecient were as low as 2.67, the spillway would still be rated as adequate.

Case II Unmodified PMF

$Q_p = 7560$ cfs (p4)
Spillway capacity = 2678 cfs

Estimate the surcharge storage effect of Crystal Run Dam by the method in inclosure 3 of the Phase I procedure package

$\Delta AOC = (1-p)\,\Delta AOB$
$\Delta AOB = 6528$ Acre-ft (p4)
$p = 2678/7560 = 0.354$
$\Delta AOC = (1-0.354)(6528) =$ 4217 Acre-Ft required storage

Assume that a right circular cone with 1V on 2H side slopes will adequately model the reservoir storage

$A =$ 18 Acres $\therefore r =$ 499.6'
$\Delta r = 2\Delta H = 2(1228.5-1224.1) =$ 8.8'
$r_2 =$ 508.4

Estimated Surcharge Storage $= 4.4\left(\frac{18+18.6}{2}\right) =$ 80.5 AF

Since the estimated surcharge storage is less than the required surcharge storage ($80.5 < 4217$) and the spillway capacity is less than the PMF peak flow ($2678 < 7560$), Crystal Run Dam cannot pass the PMF without overtopping failure.

Case II continued

Check ½ Unmodified PMF

$Q_p = 7560/2 = 3780$ cfs $Vol = \frac{6528}{2} = 3264$ Acre-Ft.

Spillway Capacity = 2678 cfs

Estimate Surcharge Storage

$\Delta AOC = (1-p)\,\Delta AOB$

$p = 2678/3780 = 0.708$

$\Delta AOC = (1-0.708) \times 3264$ Acre-Ft.

$= 953$ Acre-Ft. required storage

Since the estimated surcharge storage is less than the required surcharge storage ($80.5 < 953$), and the spillway capacity is less than the ½ PMF peak flow ($2678 < 3780$), Crystal Run Dam cannot pass the ½ PMF without overtopping failure.

Check tailwater

① Top of dam El. 1228.5
② Downstream Channel El. 1192
③ depth at Q = 2678 + 1580 cfs = 4258 cfs = 12.4'
④ Tailwater Elev. = 1204.4
⑤ ① - ④ = 24.1 ft headwater - tailwater

Calculate % of PMF which can pass the dam

$$\% = \frac{\text{spillway capacity} + \frac{2\,(\text{surcharge storage})}{T}}{\text{PMF peak flow}} \times 100$$

$$= \frac{2678 + \frac{2 \times 80.5 \times 43560}{20.9 \times 3600}}{7560} \times 100 = 36.6\% \text{ of the unmodified PMF or } 2770 \text{ cfs}$$

Effect of raising top of dam to Elev. 1230.0

Spillway Capacity

$$Q = 3.09 \times \left[(38 \times 5.9^{3/2}) + (35.9 \times 5.4^{3/2}) + (54 \times 4.2^{3/2})\right]$$
$$= 3.09 \times (544.6 + 450.5 + 464.8) = 4511.1$$

Surcharge Storage from p 9

$$\Delta r = 2\Delta H = 2 \times 5.9 = 11.8$$

$$A_2 = \frac{\pi}{43560} \times (499.6 + 11.8)^2 = 18.9 \text{ Acres}$$

$$V = \left(\frac{18 + 18.9}{2}\right) \times 5.9 = 108.8 \text{ Acre-Ft.}$$

$$\% = \frac{4511 + \frac{2 \times 108.8 \times 43560}{20.9 \times 3600}}{7560} = 61.3\% \text{ or } 4640 \text{ cfs}$$

DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX D

PHOTOGRAPHS

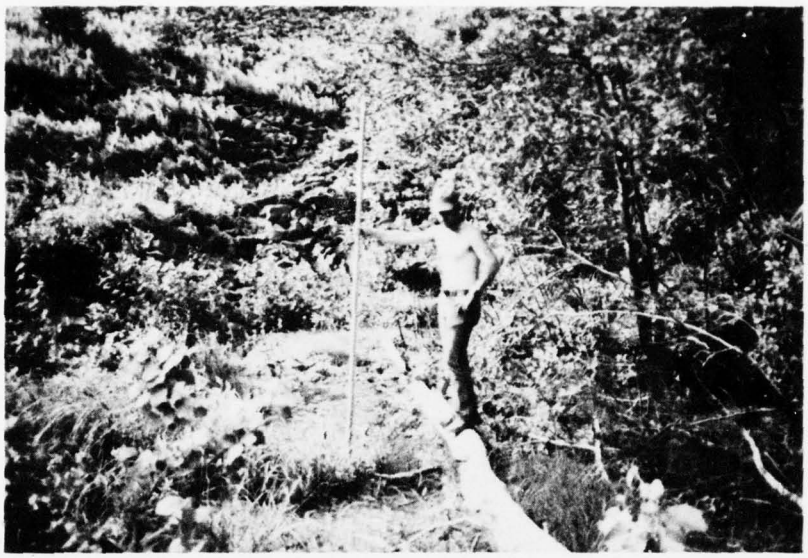
CRYSTAL DAM

A. Upstream Slope of Embankment.

B. Downstream Slope of Embankment.

C. Left Spillway — View from Upstream.

D. Right Spillway — View from Downstream.



E. Wet Area at Toe Near Left Abutment.

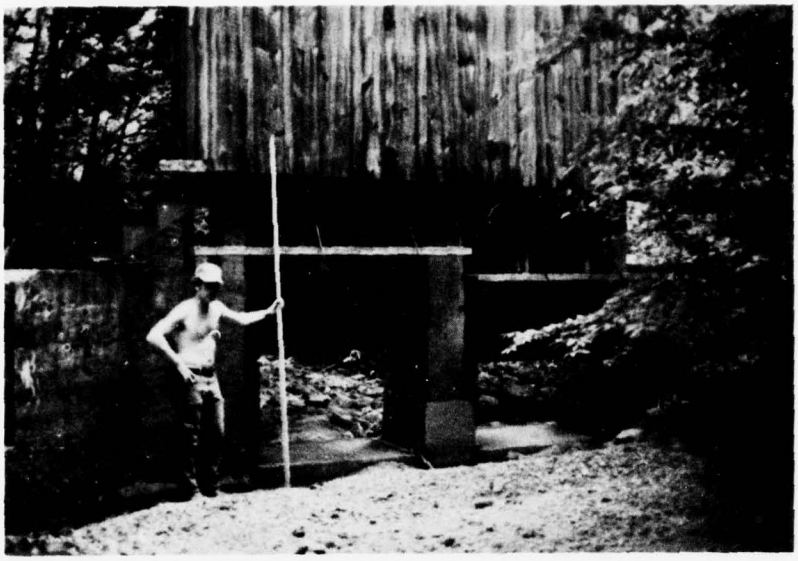
F. Wet Area at Toe
50 Feet Right of Gatehouse.

G. Left Spillway Discharge Channel.

H. Right Spillway Discharge Channel.

J. Strip-Mined Area of Watershed.

K. Flume Around Strip-Mined Area.



L. Right Side of Diversion Structure —
View from Upstream.
Diversion Channel in Background.

M. Left Side of Diversion Structure —
View from Upstream.
Original Channel of West West Branch Schuylkill River
in Background.

O. Excavated Area Between Diversion Channel and Original Channel of West West Branch Schuylkill River. View from Diversion Channel.

P. 20-Inch Blowoff During Operation.

DELAWARE RIVER BASIN

WEST WEST BRANCH SCHUYLKILL RIVER, SCHUYLKILL COUNTY

PENNSYLVANIA

CRYSTAL DAM

NDS ID No. PA-00677
DER ID No. 54-15

MUNICIPAL AUTHORITY OF THE TOWNSHIP OF BLYTHE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

AUGUST 1978

APPENDIX E

GEOLOGY

CRYSTAL DAM

APPENDIX E

GEOLOGY

1. General Geology. The dam and reservoir are located in Schuylkill County. The county lies entirely south of the Wisconsin and Illinoian drift borders. The Jerseyan drift border is believed to traverse the middle of the county, but very few definite deposits of drift have been located. The rock formations exposed in Schuylkill County range from the post-Pottsville formations of Pennsylvania age, down to the Tuscarora sandstone. The youngest formations, the post-Pottsville, crop out in the large southern anthracite field and part of the western middle field. The oldest formation, the Tuscarora, crops out along Kittatinny (Blue) Mountain which forms the southern boundary of the county.

The geologic structure of Schuylkill County is complex. The strata have been sharply folded along northeast axes, and the truncated hard and soft beds now form an intricate system of long narrow ridges and valleys. The carboniferous rocks suffer the most intense folding and are overturned in many places. The most important structural feature economically is the large synclinorium of the southern anthracite field which occupies the center of the county. This basin consists of a number of smaller connected basins, which become successively deeper and have steeper sides as they progress towards the south. In the southern part of the county, the Silurian and Devonian rocks have been folded for some distance on both sides of the Schuylkill River. An anticline passing eastward from Cressona exposes the Cayuga group and part of the Clinton formation. A syncline extending west from Landingville exposes the Catskill group. The Lehighton anticline of Carbon County extends into Schuylkill County as far as Reynolds. The ridge north of Port Clinton is an anticlinal ridge exposing the Clinton formation, and a syncline crosses the Schuylkill River just north of Port Clinton exposing the Cayuga group.

The geology produces a complex runoff pattern in Schuylkill County whereby there is drainage in five different directions. The northwestern part is drained by Mahantango Creek and smaller streams, all of which drain into the Susquehanna River north of Harrisburg. The southwestern part is drained by Swatara Creek, which drains into the Susquehanna River south of Harrisburg. The northernmost part is drained by Catawissa Creek, which drains into the north branch of Susquehanna River upstream of Danville. The eastern portion of the county is drained by tributaries of Lehigh River, which in turn drains into the Delaware River near

Easton. The central and greater part of the county is drained by tributaries of Schuylkill River, which in turn drains into the Delaware River near Philadelphia.

2. Site Geology. The damsite is located in the central part of Schuylkill County. The area is drained by the Schuylkill River and geologically is part of the large synclinorium of the southern anthracite field. Both the post-Pottsville and Pottsville formations are highly folded and fractured in this area. The dam is founded upon soft gray conglomerate and hard, gray fractured sandstone formations that could be either post-Pottsville or Pottsville in origin. The drawings indicated that cutoff trenches, called puddle ditches, were excavated to depths in excess of 20 feet into the sandstone and conglomerate rock and filled with wet puddled clay in order to achieve a positive cutoff through the soft and fractured rock. These cutoffs extended completely across the axis of dam and under the spillways. Workable Pottsville coal seams are located in the drainage area and are presently being excavated by stripping methods.